DRONE PILOT'S MANUAL

DRONEYBEE

Contents

Introduction

Congratulations! You now have the handbook that contains all the information you need to go from being someone with absolutely no skill flying a multirotor drone to a being a professional pilot capable of using advanced piloting skills in nearly all permutations of possibilities that the world may throw at you.

We are incredibly excited for you because after patiently reading and applying this manual, you will be one of the top 5% of the pilots who will not only be skilled in using the technologies that modern multirotor "drones" come with in the most optimal way, but you will also become one of the very few pilots who can ACTUALLY fly a multirotor with little or no assistance.

And if you are already skilled at flying multirotors, this manual will help you fill in any skill holes you may be missing. You will also learn to pick the right multirotor according to the circumstances.

What you do with your new found powers is entirely up to you. Like any mutant with super powers, you can do good, evil, make money or just enjoy flying about. Being a person with good piloting skills will not only enable you to have fun flying hobby multirotors, but will also open up new opportunities for you in this

new and fast growing industry in a myriad of different applications including:

- Aerial photography
- Agriculture
- Search and rescue
- Infrastructure inspection, maintenance and security
- Package delivery

...And many more, including participating in drone races!

Even if you may never have to actually fly a multirotor in your job or business, this manual contains information that will be invaluable to you. This drone pilot manual will also enable you to quickly train your employees in the art of piloting and picking the right multirotor for the job.

Why learn how to manually fly?

A large portion of this manual is about mastering how to fly your multirotor without assistance, the old school way. Let's not pretend – it's not going to be easy at all. So why bother?

Turns out, there are a myriad of reasons why you shouldn't rely on stabilization technology alone if you are serious about flying drones. Technology is great but your skill will never truly improve if you rely on it to fly your craft from the beginning.

Technology should be layered on top of your skill for maximum piloting efficiency. Here are some of the main reasons why you should learn and develop the skill to fly manually:

- It will help you get through tight spots during emergency situations
- It will help you maneuver through closed spaces
- It is incredibly useful for awesome photography – your skill limitation will be definitely holding you back from capturing optimal images and video. The ability to maneuver a drone to the right locations and positions at the right time is essential for any serious aerial photographer

- It is incredibly useful for inspection – Same as photography, the skill to maneuver is extremely valuable.
- Drone racing! Even if you aren't planning on competing in professional drone racing leagues, we don't think there exists a more fun activity to engage with your friends.

Safety, privacy and regulations

Before you begin your journey into multirotors, it is important to address one of the most important considerations – safety. You have to keep in mind that multirotors are not mere toys. Even toy grade multirotors are capable of causing significant damage if you are not careful (propeller damage to the eye much?) . Carelessly flying can not only cause injury to yourself, but also to others around you. This is especially true if you are beginner. If you are not sure about your flying skills, stay away from experimenting in closed spaces and around other people until you develop the necessary skills.

- Here are some of the safety guidelines you should follow:
- Avoid flying near airports and interfering with manned aircraft
- Avoid flying in places that are crowded with people, pets and vehicles
- Try not to fly in adverse weather conditions (How to fly in winter is covered in this book)
- Try and stick to daylight flying most of the time
- Do not drink and fly :-)

- Avoid flying over sensitive property such as power stations, water treatment facilities correctional facilities, government facilities etc.
- Above 400 feet (varies from country to country)

Safety however is just one piece of the puzzle. You must also respect others' privacy. Do not perform surveillance or take photographs of people in private property. Also, do not fly your drone above private property (other than your own, of course).

Always keep yourself updated with the regulations of your country. Refer to the following websites:

http://knowbeforeyoufly.org/ (Mostly US based, but safety advice apply everywhere)

FAA website (US)

CASA website (Australia)

Transport Canada website (Canada)

CAA website (New Zealand)

CAA website (UK)

Google the search term: "Country" + drone laws if your country is not listed above.

Also, refer to the following page for no-fly zones (US only): http://knowbeforeyoufly.org/air-space-map/

Drone modes, acronyms and terminologies

While not all drones come with every mode, it is important to understand the different flight modes and how they fly differently. Here are the most common modes you must be familiar with, before attempting to fly with your drone:

- Acro mode (or manual mode or rate mode) – This is the configuration mode you'll be practicing in, if you are going to use this manual. It is the hardest mode to fly in, but it gives you full control over the craft enables you to perform aerobatics. We recommend that beginners practice on acro mode because it is where you really get good!
- Self-level mode or Altitude mode – Easier to fly than acro mode, the self-level mode is where most people usually start with, especially when they buy a hobby grade, semiprofessional drone or above. Like the name of the mode suggests, the self-level mode will always try to keep the drone in "level", when you use the roll and pitch function and even when you even if you let go off the sticks.

- RTH, RTL (Return to home or return to land) – This mode comes with most hobby grade multirotors and above. It brings back the drone to its owner autonomously.
- Loiter mode – The craft will hold the altitude.
- Follow me mode – As the name suggests, follow me mode can be toggled to make the drone follow its owner who would be holding the controller.
- GPS mode (or auto mode or waypoint mode) – Autonomous flight mode initiated by setting up waypoints on maps.
- Point of interest mode – Set a specific object as the point of interest and the drone will circle around it.

Of course, these are only the most common terminologies for the most common drone modes. Ardupilot for example, has many more modes (most of which are a mixture or a spectrum level of the above modes).

Understanding drone modes will help you understand many of the terminologies that are used in the multicopter/drone world, but here are some more that you should know and refer back to:

Term/Acronym	Meaning
ACC/Accelerometer	A device that maintains drone's orientation by measuring acceleration forces. Used for stabilization.

AIL/ Aileron	'Rolling' action done by the multirotor.
ARTF/ ARF	Almost ready to fly multirotor is usually a kit that includes everything that you need to fly, but requires assembly.
Barometer	A device that measures altitude by measuring barometric pressure.
BEC	Battery eliminator circuit is a voltage regulator that is usually found in ESCs. It provides regulated voltage (usually about 5V) to motors, flight controller and receiver.
BNF	Bind and fly multirotors are ones that do not come with a transmitter/receiver with enough channels. If you already have a compatible transmitter, getting a BNF version of the multirotor can be a big money saver.
Binding	Processing of connecting the transmitter with the receiver

Types of drones and differences in performance (pictures needed)

Fixed wing vs. multicopter

When we think of small "drones", we usually think of a multirotor drone. Though in this manual we are going to focus on multirotor drones and how to operate them, it is important to keep in mind that small, fixed wing drones are also out there and they fly very similar to RC planes. The key difference is that "drones" have the capacity to fly autonomously.

If your goal is search and rescue or surveying a large area, a fixed wing drone is the way to go. It can cover a lot more ground and can stay in the air a lot longer. Multirotors are the least efficient when it comes to flight times.

That being said, most applications of small drones including aerial cinematography, precision agriculture and tight asset inspection (especially in constrained environments) are usually met by multirotors due to its maneuverability and its capability for vertical takeoff and landing and this is why multirotors are getting more popular today than ever before.

If you want a guide on flying fixed wing drones, we suggest you start with flying drones.

Tricopter vs. Quadcopter vs. Hexacopter vs. Octocopter

The Tricopter

The main advantage of a tricopter is the build cost. Less motors and parts mean less probability of failure, making them more reliable and technically, more "resilient" in that sense, compared to the quadcopter (We'll soon see how it doesn't apply with the hexacopter and octocopters).

The tricopter used to be more popular when costs of individual components (i.e. price of motors, ESCs etc.) were much higher than that of today. Today, this argument might not make as much sense in all cases, especially with smaller crafts, since parts come much cheaper.

The placement of the YAW control at the tail of the craft makes the craft feel agile and "smooth", especially while performing turns and bank turns. The FPV experience on a tricopter may be hence, unmatched by any other type of multirotor configuration.

Building a tricopter is also more difficult than building a quadcopter. If you are a beginner in terms of building a craft, a tricopter is probably not the way to go at this point.

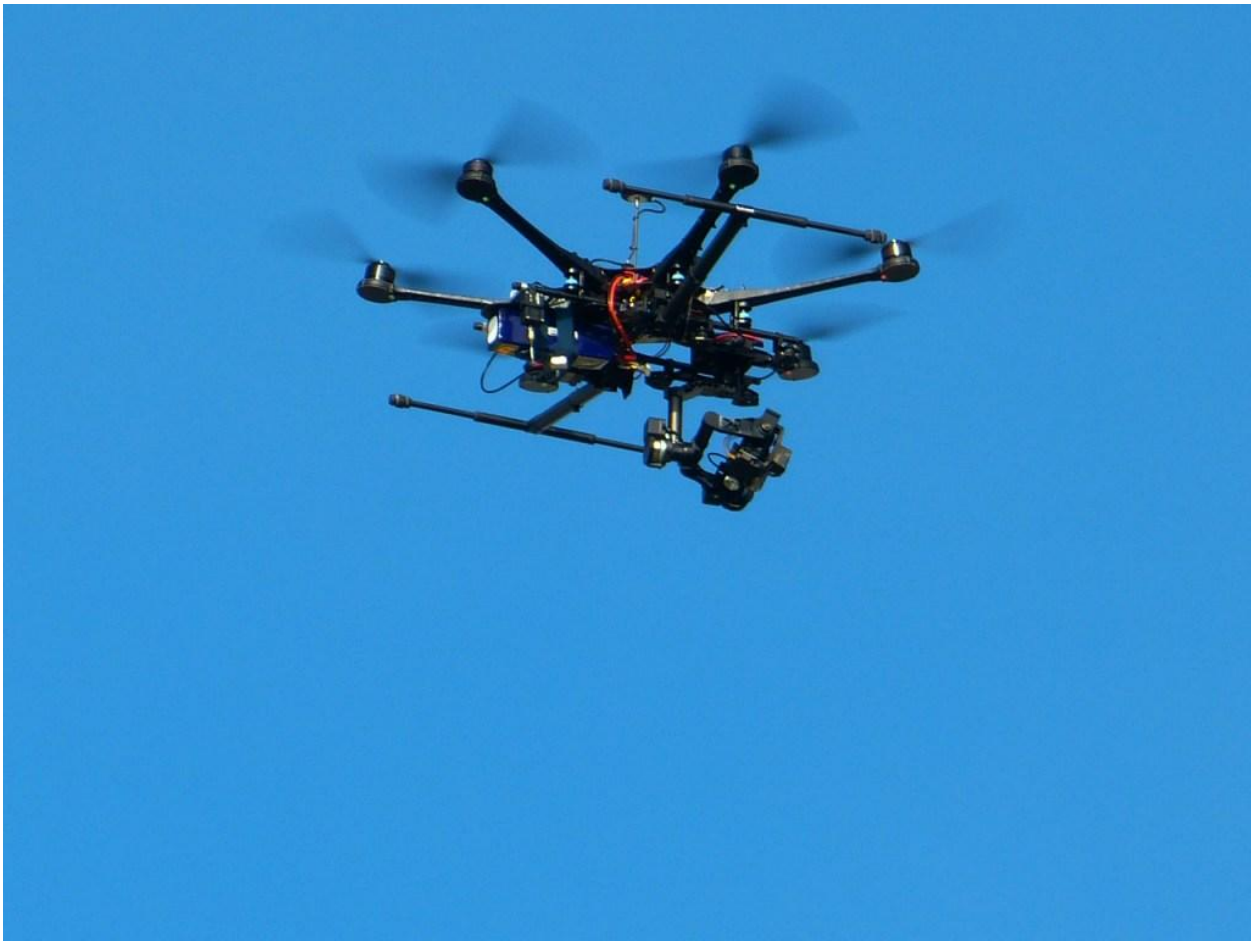
The Quadcopter

The most popular multirotor configuration out there in the market today is the quadcopter. This configuration is adopted by a wide range of differently capable multirotors including FPV racing quads and quads that are capable of photography and videography (example being DJI's phantom or Inspire series).

The quadcopter has more lifting/thrusting power than the tricopter but may feel less agile while turning. This configuration is probably the easiest to setup if you want to build one from scratch. There are plenty of guides out there for building quadcopters of a wide array of different sizes and shapes. If scaling up and carrying

larger payloads is what you are looking after, start by looking at the quadcopter instead of a tricopter.

The Hexacopter



The hexacopter offers everything that the quadcopter does, plus more. While scaling up to bigger multirotors, this configuration offers more power, efficiency, stability and capacity for carrying heavier payloads than a quadcopter.

They are also pricier than the quadcopter, but they come with an inherent increase in reliability. If one of the motors fail for example, these crafts would still be able to fly fine enough to make a safe landing. With quadcopters or tricopters, this is simply not the case.

If you are a semi professional photographer or a UAV pilot working for a company that does infrastructure inspection, the hexacopter is where you might want to start with.

The Octocopter

Ocotocopters are the most powerful, efficient, stable and capable of carrying heaviest payloads in the large multirotor arena. They are the top tier and are also the most expensive. The upside to this is that they are also the most reliable. Failure of a single motor won't really affect its flying capabilities, except for efficiency in terms of battery life.

If you are a professional photographer or an experienced UAV pilot and you need your multirotor to be able to carry heavy payloads, (for example heavy, capable camera equipment) the octocopter is the way to go.

Flight characteristics compared, in a nutshell:

Flight time: The argument that tricopters have longer flight times than a quad for example, because of one less motor may not always hold true. There are many factors that have to be taken into account. The main theme revolves around the total amount of work done by the motors to get the craft up. Less amount of motors equal less power and thrust. The existing motors must hence, work harder. Generally, you want a good thrust to weight ratio for maximum flight times. For larger quads capable of carrying heavy payloads, this thrust to weight ratio is best realized with hexacopter and octocopter configurations. For smaller ones, tricopter/quadcopter is probably the way to go.

Agility: Regardless of the configuration, smaller multirotors are generally more agile and maneuverable. There is a reason why FPV racing drones are in the 250 size range. Other than size, tricopters can be said to be the most agile due to the way the YAW configuration is setup and not because of the fact that there are less motors. A quadcopter with a V-tail configuration can have similar YAW configuration, making it feel more agile.

Stability: Generally the larger the quad, the more stable it is. However after a certain point, there are diminishing returns with size. It is not possible to indefinitely scale a multirotor and reap the benefits of scaling. As a result, building a multicopter like a hexacopter that has additional motors improves the overall thrust, power and stability of large multirotors that are generally used to carry heavy payloads (like heavy camera equipment).

Payload capacity: Obviously, payload capacity would directly proportional to the size of the multirotor. But like we discussed for stability, size cannot be indefinitely scaled and hence, hexacopters and octocopters are used for managing large payloads.

Quadcopter frame configurations

Since quadcopters are the most common type of multirotors, it is worth discussing the different types of frame configurations you can see with them.

X-Copter

The X shaped frame is the most common type of frame configuration. It is the most structurally efficient and flies really well but they offer the least amount of space for putting on accessories such as a camera.

I-Copter

The I-configuration may not be as stable as the X-copter, but they offer the most in terms of space, making it the ideal frame type for FPV drones that are built for racing, for example. I shaped frames are also built so that the arms are at an angle. The arms are usually built at an angle of 120 degrees and 90 degrees. The larger the angle, the more stable the craft will be.

H-Copter

The perfect H-configuration also has a lot of space, like the I-copter but they are the least stable configuration.

Sizes

Regular sized drones aside, multirotors come in "Nano" and "Micro" sizes. We suggest you get these instead of regular sized drones if you are a beginner. Nano and Micro sized drones are usually cheaper.

Want to fly indoors?

The one thing that is different about an "indoor" drone is size. If you want to fly indoors, maneuverability is everything. The smaller the drone is, the better it will fly in closed spaces, around objects and in spaces between them. Nano-sized drones (ones around the size of a coin) are the most ideal. At the same time, they'll be quite lacking if you take them outdoors.

The decision, then, is based on trade-off. When considering what to get, it is advisable to first decide whether you want the best possible indoor flight experience or if you want to trade some of that for the ability to occasionally fly outdoors. In case of the former, it is advised to get a Nano drone. Otherwise, go for a micro sized drone.

Drones, their purposes and differences

Apart from build, number of rotors, shape of the frame and sizes, there are a wide variety of different drones out there that are built for different purposes. You can't for example, expect to win drone races or fly swiftly through trees and obstacles if you get a DJI Phantom drone that is built for photography.

Pick one that suits your needs the most. Of course, all of this is invalid if you are a beginner and/or doubt that your flying skills

are lacking. How to pick your first drone is what we'll be covering in the next chapter, so hold on tight!

Your first multicopter drone

If this is your first time purchasing a drone, we recommend you avoid the expensive drones till you get enough practice and muscle memory to fly without conscious thinking. And if you already have a drone that is fairly expensive, we recommend you follow the advice in this chapter before using this manual to train your piloting skills. You don't want to wreck that $1000 drone within the first few days of flying unless you have a magic cash machine.

Sure, one could argue that it comes with many features that make it easier to fly, but it doesn't mean that you won't crash. Either way, it is better to learn how to fly manually, giving you flexibility to fly however or wherever (within law's limits) you want it to.

Cheap mini drones under $50 are perfect for this (you do not need to buy the exact models we have reviewed, but it can be used as a reference). Also, you might want to go for a RTF (Ready to fly) model as your first purchase. Be especially careful about this if all you want is to unpack that box and be ready to go. Not all drones come ready to fly.

RTF (Ready to fly drones)

RTF drones come with everything pre-packaged and built in the box, ready to fly as soon as you unpack it. All you need to do usually is put in some batteries, turn on and voila! This type of drone is what I would advise most beginners to buy as their first quadcopter drone.

You do not have to undergo the pain of putting the parts in place and going through a plethora of internet forums and websites to find customization, tuning and software options.

Some **BNF (Bind and fly)** drones also exist, which requires you to bind your transmitter to the drone to fly. If you have a transmitter that you are sure is compatible with the model that you want to purchase, this option can save you a lot of cash as you need only pay for the drone itself and not the accompanying transmitter. Most RTF models tend to have instructions that are very detailed and communities to help you with any problems you might encounter.

If this is your first time entering the hobby, definitely go for the RTF drone as all you need to do would be to learn how to fly without overwhelming yourself too much.

ARF (Almost ready to fly drones)

Do you like to tinker with electronics? Do you want to have a better understanding of the ins and outs of your drone? If so, you might want to go for an ARF (Almost ready to fly) Kit.

Building your own drone from a Kit can be in fact, very educational and satisfying. This will be especially helpful if you want to repair your drone, fine tune it and upgrade it.

After you have played around with a couple of RTF drones, this might be the way to go. Specific details regarding this are covered in the drone garage manual. We would advise against this as your first quadcopter drone.

Price and spare parts

Drones usually range from as low as tens of dollars up to several thousands. Smaller, basic drones are obviously cheaper and are perfect for the beginner hobbyist trying to learn the ropes making it ideal as your first quadcopter drone.

It is advised that you buy small but quality RTF drones (usually around $50) as your first quadcopter drone before working you way up. This will help preserve the paper in your wallet should you crash during your early flying experimentations.

With cheaper drones, it is also easier to replace any damaged parts with spares. It would cost you a fraction of a fraction of the costs of repairing a fancy, expensive drone.

You might as well buy multiple smaller, cheap drones to use it as spare. Remember – you are better off learning how to fly the thing first!

Things you would want to buy in advance as spare and for parts maintenance –

- Propeller blades.
- Batteries (Most brands usually have an extra battery that come out of the box).
- Motors
- Propeller balancer
- Tachometer (to measure motor RPMs)

Controls and difficulty for your first quadcopter drone

Drones come with different controls and ease of use. From using a traditional joystick transmitter to an easy to use phone app, a drone can be controlled in many ways.

Beginners looking to learn how to fly a drone should probably steer clear of phone apps and GPS controls in your first quadcopter drone.

How you choose to control your drone is entirely up to you of course, but a traditional transmitter will force you to learn how to control your drone fluidly in a wide variety of scenarios and environments.

Another thing to note now is the number of axis. A 6 axis drone will be much easier to fly relative to a 3 axis one due to gyro stabilization. Though most drones that come out today are moving toward 6 axis, a beginner looking to learn how to fly a drone would be better off purchasing a 3 or even a 4 axis drone.

The skill you acquire from flying such a drone will come in handy once you move up the price and sophistication ladder. You will be much more equipped and confident to handle your drone without crashing and destroying it.

This might seem counterintuitive, but I'd suggest picking a relatively 'not so easy to use' model as your first quadcopter drone

to maximize learning. The pricing and sophistication is the only thing you need to 'ease' on for now. You'll thank us later!

Battery

Most micro and mini drones have a battery life enough to have a fly time of about 10 minutes. This is might be plenty of time for some, but not enough for most. This is why its worthy of stating again and again that buying more batteries as a spare is a good idea.

Charging them before you head out on your flying adventure will give you more flight time. Batteries are usually charged with a USB cable or with a plug in AC charger depending on your purchase and typically takes about half an hour to an hour.

The drone transmitter also requires battery and this might be AA or AAA batteries. Make sure you take proper care to charge your batteries, especially the LiPo batteries. Some batteries can be extremely flammable, so please be careful! It is also important to learn how to properly maintain your batteries, as soon as you get your first quadcopter drone.

Camera

Most micro or nano drones under $50 typically do not have a camera. Even the ones that do have cameras do not come with a quality one. As a beginner making your first quadcopter drone purchase, it might be best to just overlook the camera feature and buy something that can help you learn to fly.

As you get to your second drone, you can then look for one that will give you that amazing photography and videography experience, along with that FPV (First person View). By then you will already be a well-rounded drone pilot capable of utilizing such features!

Flight Modes

As we've already covered, depending on the Drone, there may be many different modes for flight.

The most basic mode of a drone is the Arm (also ACRO, Rate or Manual) mode. This particular mode only requires one type of sensor – the gyro sensor. This mode is what you'll be focusing your attention on, as a beginner, to master your flight skills.

Most basic drones that you'll want to purchase as a beginner will only typically have the gyro sensor anyway. And this typically is all you will need for your first quadcopter drone.

The other mode that you may be interested in using frequently with your first drone is the self-level mode. This uses another sensor – the accelerometer to stabilize your flying. This can be more newbie friendly, but reduces your scope for practice.

Where and when to fly: Considerations before flying a drone

We've discussed where NOT to fly in the safety, regulations and privacy chapter. However, we've not really addressed what is the

ideal location to fly. In this chapter we shall discuss the ideal place and situation to fly a drone but we'll also cover how to fly a drone in trickier conditions. Namely, we'll cover how to fly a drone in winter and how to fly above water bodies, minimizing the risk of damage.

The ideal place, time and setting to fly a drone

If you are a beginner, we advise you to stick to the ideal place and time to fly a drone laid to you here. It is not a matter of IF you will crash; it is a matter of WHEN you will crash, if you are a beginner. Even if you are fairly advanced, the following are the conditions that we recommend you consider before flying a drone for practice:

- Open field: Make sure there are no people or pets around. If you have a backyard that you can practice your drone flying skills, perfect.
- Low wind conditions: If you are going to purchase a Nano or micro drone, you will need to make sure that the wind won't toss your craft about.
- Consider flying indoors: If you have large enough space indoors, consider practicing flying indoors. Make sure you are flying a micro or better yet, a Nano drone!
- Keep your drone very close to line of sight.
- Keep a safe distance from your craft

- Avoid bad weather and winter flying: If you are a beginner, we recommend you not fly outside in winter. Your drone may get lost and worse, may potentially cause injury to you or someone else if it goes out of your line of sight. Winters can get unexpected!
- Avoid flying above water bodies: This one is obvious. You do not want to lose your drone when you are practicing.
- Make sure the propellers are balanced.
- Make sure the batteries are charged properly
- Make sure the batteries are not unusually hot or puffed up.

Flying in winter

What if you absolutely WANT to fly in winter? Is there no way to circumvent some of the risks and enjoy flying your drone in the winter? How do photographers use drones to capture amazing aerial footages in winter then? Are there any guidelines you can follow? Absolutely! It is exactly what we are going to cover in this section:

Make sure you have visibility

In winter, everything is going to be hazy. And this means less visibility and more difficulty in keeping your heads up while flying a drone in snow.

Even if you have an FPV camera, it is necessary to make sure you have visibility, in case of any connection loses! Flying out of your line of sight is not recommended during winter.

It is pretty easy to lose sight of your drone even if your flying skills are top notch and your eyes are as sharp as an eagle's. Winter is unpredictable and it can get hazier and windier pretty quickly than when you just headed out.

Installing an LED light on your drone is the easiest way to improve visibility. Fly in the part of the sky where the sunlight is, for more visibility.

If possible, giving it a red repaints (or over-paint) or vinyl might help (longer wavelength, remember?). This can be especially useful if your drone is white. A black repaint might also be a good idea, though not as great at night.

Keep your hands warm

You can do everything you want to alter your drone for the winter, but if your hands (and you yourself) are cold, it will not be pleasant flying a drone in snow.

Numb fingers can not only be unpleasant, but can drastically have an impact on your flying skills and you don't want your flying skills to be sub-par, ESPECIALLY during winter when you will be flying a drone in snow with reduced visibility and increased potential for damages!

Getting gloves and hand warmers can go a long way if you are headed out for flying during winter. A Transmitter glove is a great RC specific option if you find that it is difficult to fly with gloves on.

Coat your craft before flying it out in winter

Before you go out flying a drone in snow, coat the electronics within your craft with something to protect it from not only melted snow, but also from the cold.

Some of you may have drones that are already 'waterproof' straight of the box, but for those of you who don't, coating your electronics with Corrosion X or Never Wet can go a long way.

There are plenty of potential ways by which you can add protection to the inner part of your drone. There are a lot of options and you can even use Tupperware to cover up the entire quad-copter!

Expect lower flight times in winter

Cold weather can really take a toll on your Li-Po batteries. If not well taken care of, expect to damage and puff up your Li-Po during winter. After you are done flying a drone in snow, it is very important to note that you should never immediately charge a battery that has been in the cold. Wait for it to warm up!

Use a battery heater or place the batteries on top of a car heater to warm up it up before you head out. This will make your batteries have a good start with its temperature. Cover up your Li-Po with some sort of warm cold resistant substance to ensure further cold resistance.

Even if you have all of the above in place, expect lower flight times. It is also necessary to save up some amount of battery life in case of emergencies like heavy wind or haze build up to safely bring your quad-copter back to the ground.

Calibrate appropriately

Sensors and gimbals within your drone can act weird in colder temperatures. You shouldn't be surprised if the ESCs and gimbals calibration of your drone is off.

Ideally, you should do the calibration and flight adjustments outside, in cold weather in temperatures where you will be flying.

Doing this will ensure that your drone is ready to fly within that specific condition, rather than the temperature indoors where it would be typically heated up.

Use wooden or carbon fiber props

Mid-flight prop failures and crashes from it can be catastrophic, not only to your craft but also to objects and people nearby. Plastic propellers fail pretty easily, even during spring and summer.

With flying a drone in snow, it would be correct in assuming that the prospect for a prop failure is even higher from all the chilling.

If possible, replacing your props for a more durable carbon fiber prop or even a wooden prop can go a long way in avoiding a potential mid-flight crash.

Replacing your existing prop for a slightly larger propeller may also help reduce the RPM required for your drone to fly, thereby reducing the risk for propeller based failures. Make sure not to overdo it overload your motors though!

Conclusion

Having a GPS or RTH/RTL system on your drone can help a lot with potential damages. If you just cannot resist the temptation for flying a ton, maybe try flight simulators till the end of winter.

Flying above water bodies

Flying above water bodies is another risky endeavor, especially if it is windy and your skills are lacking. Are there ways to add protection to your craft and minimize the risk? There are! Following are a few recommendations:

1.) **Waterproof your drone electronics**: Using water repellent coating sprays like Corrosion-X or never wet, you can make your drone water resilient. Do NOT however, deliberately use your drone like a submarine. We also do not recommend attempting this method on an expensive drone if you are unsure of what you are doing. Start cheap. A full guide can be found here: http://www.droneybee.com/waterproof-your-quadcopter/

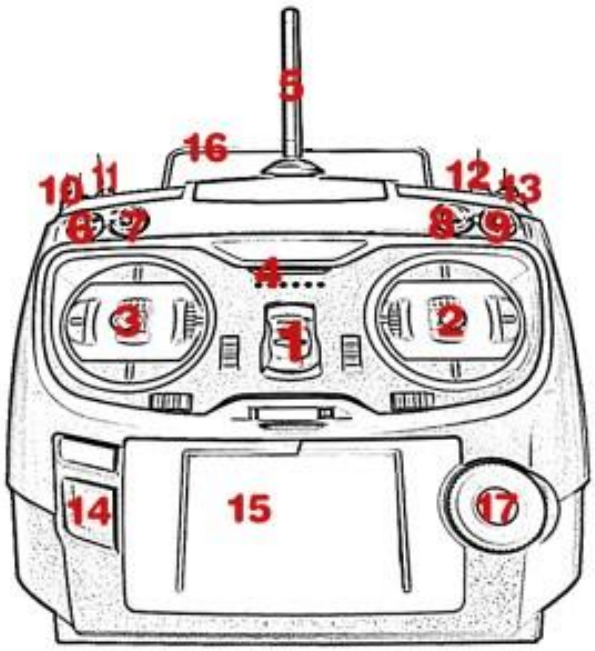
2.) **Cover your drone in Tupperware**: Covering your drone in Tupperware lunch boxes is an excellent way to minimize the risk of water damage, without the risks of trying to apply water repellent coatings. The downside to this is that your drone will get heavier, reducing flight times. It shouldn't be drastic though. Tupperware is light after all.

3.) **Attaching floating landing gear on your drone**: Though we recommend you NEVER land on water deliberately, this method

is an added protection if your drone happens to accidentally go down. Cut four different pieces of polystyrene or Styrofoam and attach two of them to the bottom of your drone's landing gear (you could glue and then tape them). Place the two pieces on the other two pieces perpendicularly and glue those together.

Getting familiar with the controls

What each control does



1 - POWER BUTTON
2 - AILERON/THROTTLE CONTROL
3 - ELEVATOR/RUDDER CONTROL
4 - POWER INDICATOR
5 - ANTENNA
6 - ELEVATOR DUAL RATE CONTROL
7 - RUDDER DUAL RATE CONTROL
8 - FLAP/AIRBRAKE MIX CONTROL
9 - AILERON DUAL RATE CONTROL
10 TO 13 - SWITCH
14 - MODE BUTTON
15 - LCD SCREEN
16 - HANDLE
17 - ENTER BUTTON

Power button is pretty straightforward. Use it to turn your transmitter on and off

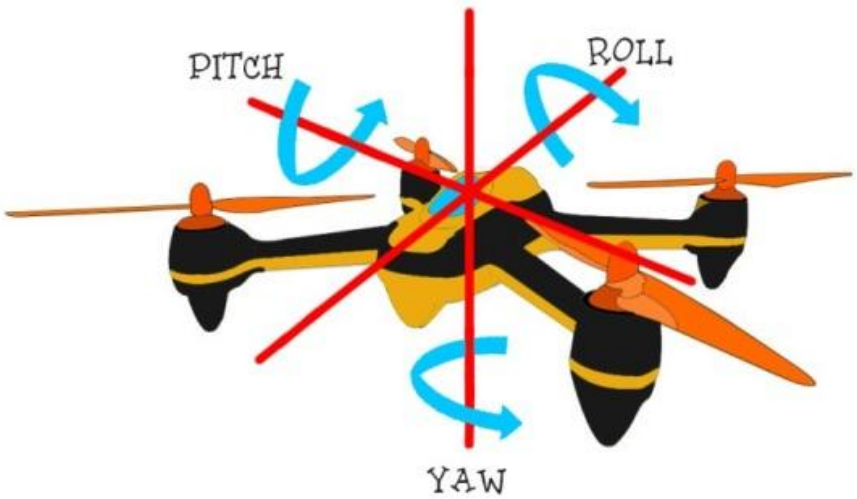
This stick is for both Aileron/Roll and Throttle. Throttle determines how much total power is drawn by the motors, determining how high your drone will go. This is essentially the accelerator for your drone. Aileron **(or Roll)** is used to sway the drone sideways, either to the left or to the right.

This stick is for both Elevator and Rudder. Elevator control is used to **pitch** your drone. That is, to move it forward and backwards. The rudder control is used to **yaw** the drone. That is, to rotate it about its axis.

Power indicator determines how much power is left.

Bigger antenna usually is better.

6 to 9. Dual rate controls can be used to switch up how sensitive each control is. This is essentially 'tuning'.



Remember these:

Aileron = Roll movement

Elevator = Pitch movement

Rudder = Yaw movement

Different modes

Do note that all controllers may not have the exact same control positions. Some controllers have the ability to change modes while others are locked into either mode 1 or mode 2.

In mode 1, the throttle and elevator function is on the right stick while the elevator and rudder is on the left stick. In mode 2, the throttle and rudder is on the left stick while the elevator and aileron is on the right stick. Make sure you know which one is yours and what you are comfortable.

Trimming and tuning

1 - THROTTLE 2 - ELEVATOR
3 - RUDDER 4 - AILERON

If you feel like your multirotor moves unnaturally, then you might need to 'trim' your craft. Trim tabs adjust the center position of each stick. If your transmitter comes with a display screen, you can usually see how much you are adjusting. In either case, you may have to experiment with the trim to find the right adjustments for your craft to fly properly. For example, if your craft has the tendency to roll to the right, you may have to adjust the trim settings of the roll function to the left.

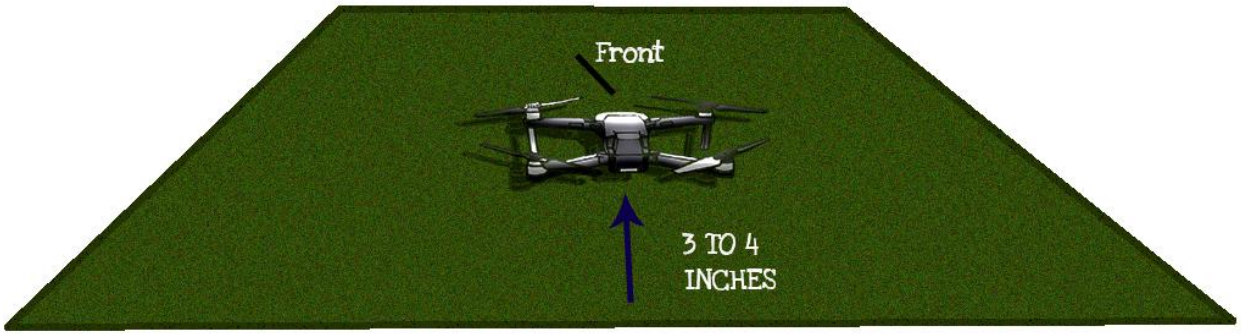
Mastering your piloting skills

Now that you have a decent understanding of drones, it is time to master flying your craft. In this chapter, you shall learn the method that many advanced pilots have used including professional drone racers and photographers to get to where they are right now in terms of skill.

Practice each step with deliberation, do not skip ahead and you shall be on your way to piloting greatness. Welcome to the club of the top 5%!

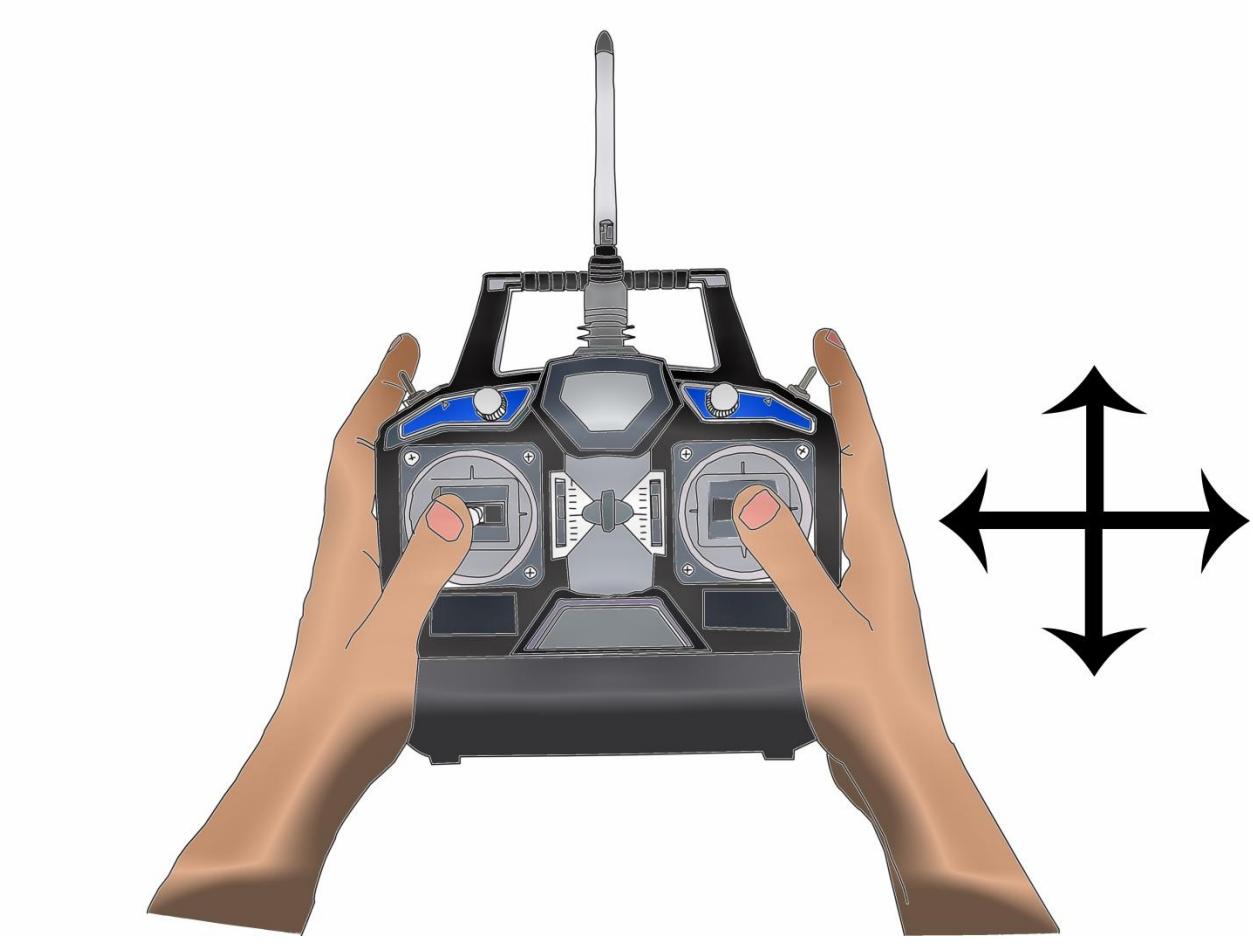
Lesson 1: Learn how to hover in place

Lesson 1.1: The simple hover



It is time to begin your training. Take your craft out there and hover it in place. That's right, no moving the craft around yet!

Use the throttle, pitch and roll controls to keep your craft in place, about 3 inches above the ground. You will have to constantly use the pitch and roll controls to keep the craft from moving about and the throttle to keep its altitude.



Spend a couple of hours and use up plenty of batteries, but do nail this part of the mission before heading to the next. Mastering this will give you a 'feel' of how the craft works and develop the

necessary muscle memory for more advanced maneuvers later in your path to mastery.

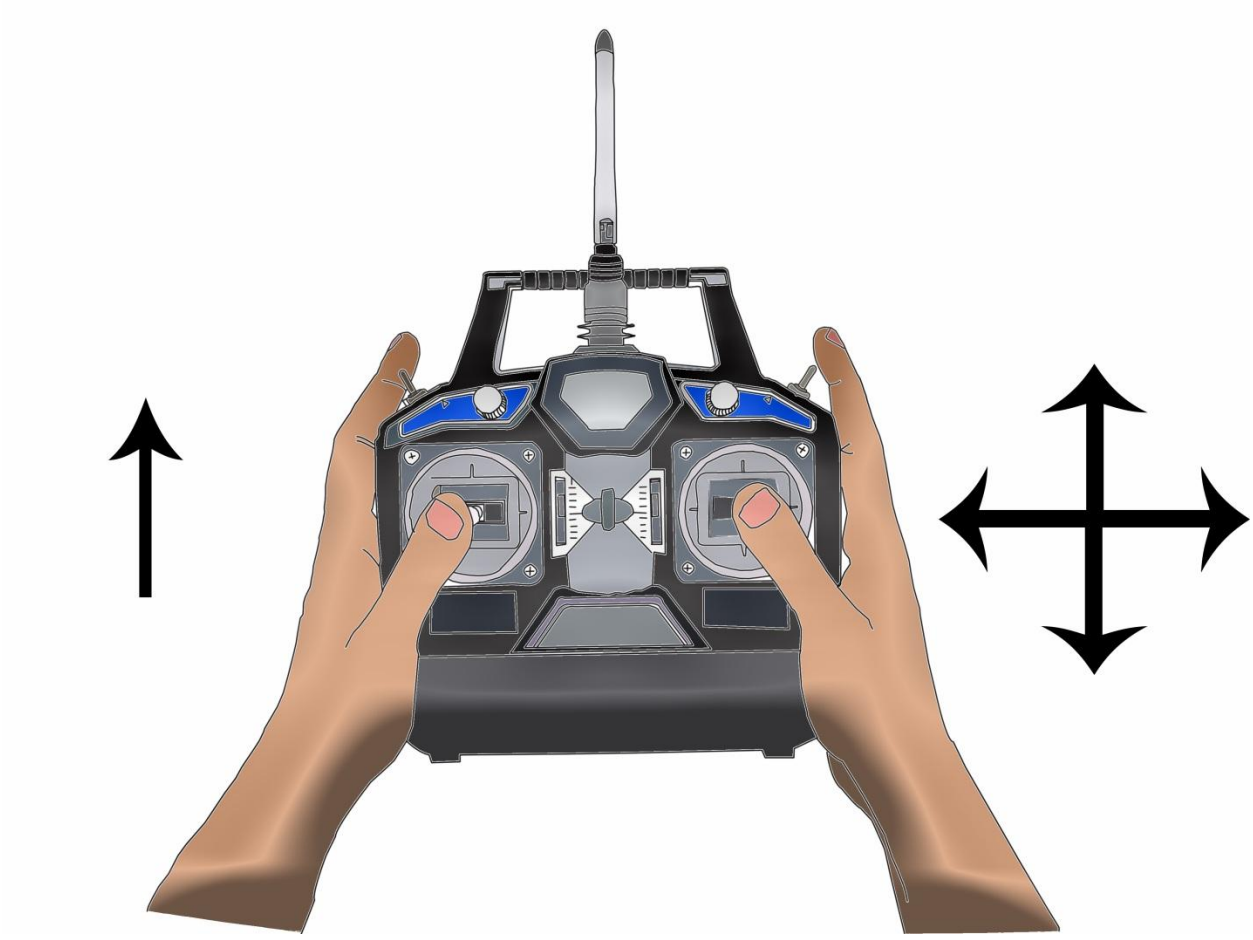
Things to note:

Keep the craft facing the same direction you are facing

Do not touch the Yaw control just yet, we'll get to this soon enough

Lesson 1.2: The ascended hover

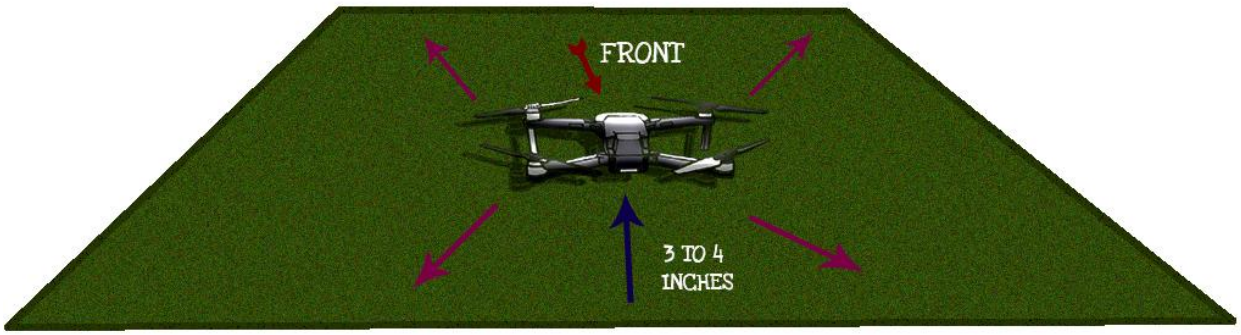
After you have mastered the previous lesson, ramp up that throttle and get your craft to ascend a bit higher in altitude. Don't fly too high, a bit higher than your head is enough. You need to be able to perfectly see whether or not you are doing well!



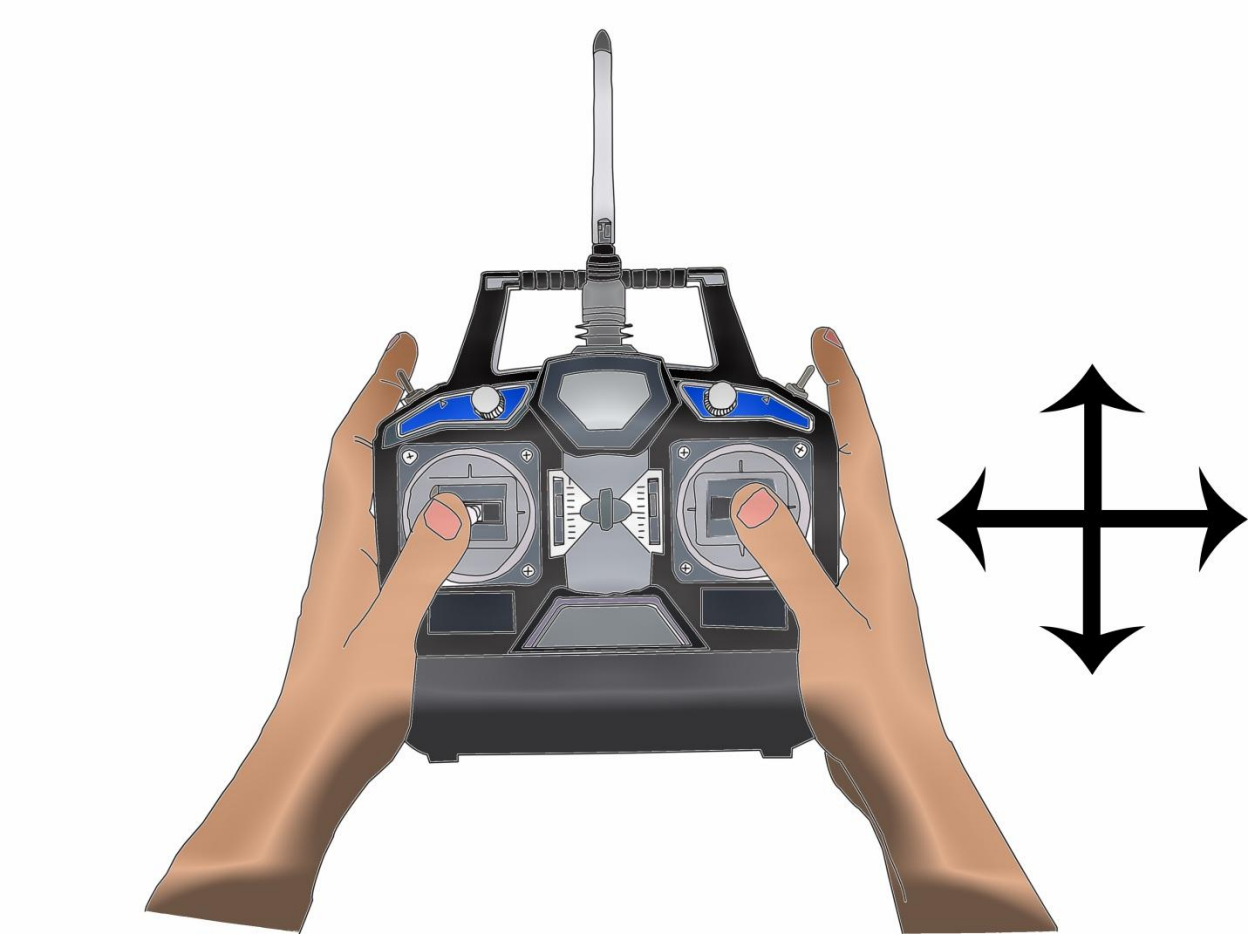
Now maintain the same altitude and position, similar to what you did in the last part of this mission. Feels a bit different, doesn't it? That's because the air behaves differently in higher altitudes. Learning how to fly at different altitudes is part of learning how to fly a quadcopter! No worries, just spend a couple of hours mastering this step before proceeding!

Lesson 2: Movement while hovering

Lesson 2.1: Move only with the roll and pitch control



No more hovering. In this lesson, you finally get to move around your craft. But wait, no touching the yaw control yet. You only get to **move around with the roll and pitch** of your craft, while keeping the craft facing the same direction you are facing.



However, don't move around frantically and all over the place. That defeats the purpose of learning. Visualize an imaginary square boundary and keep your movement within that boundary.

This will force your neurons to learn how to exhibit full control over your craft. Marking a square boundary by placing four stones at four different corners on the ground might help.

Bottom line: use the throttle, roll and pitch control to move your craft about inside an imaginary box. Spend a few battery charges mastering this.

Lesson 2.2: Walking the dog

First, throttle up your craft and make it hover at about knee or chest height. Then, move your craft forward by using the pitch

control.

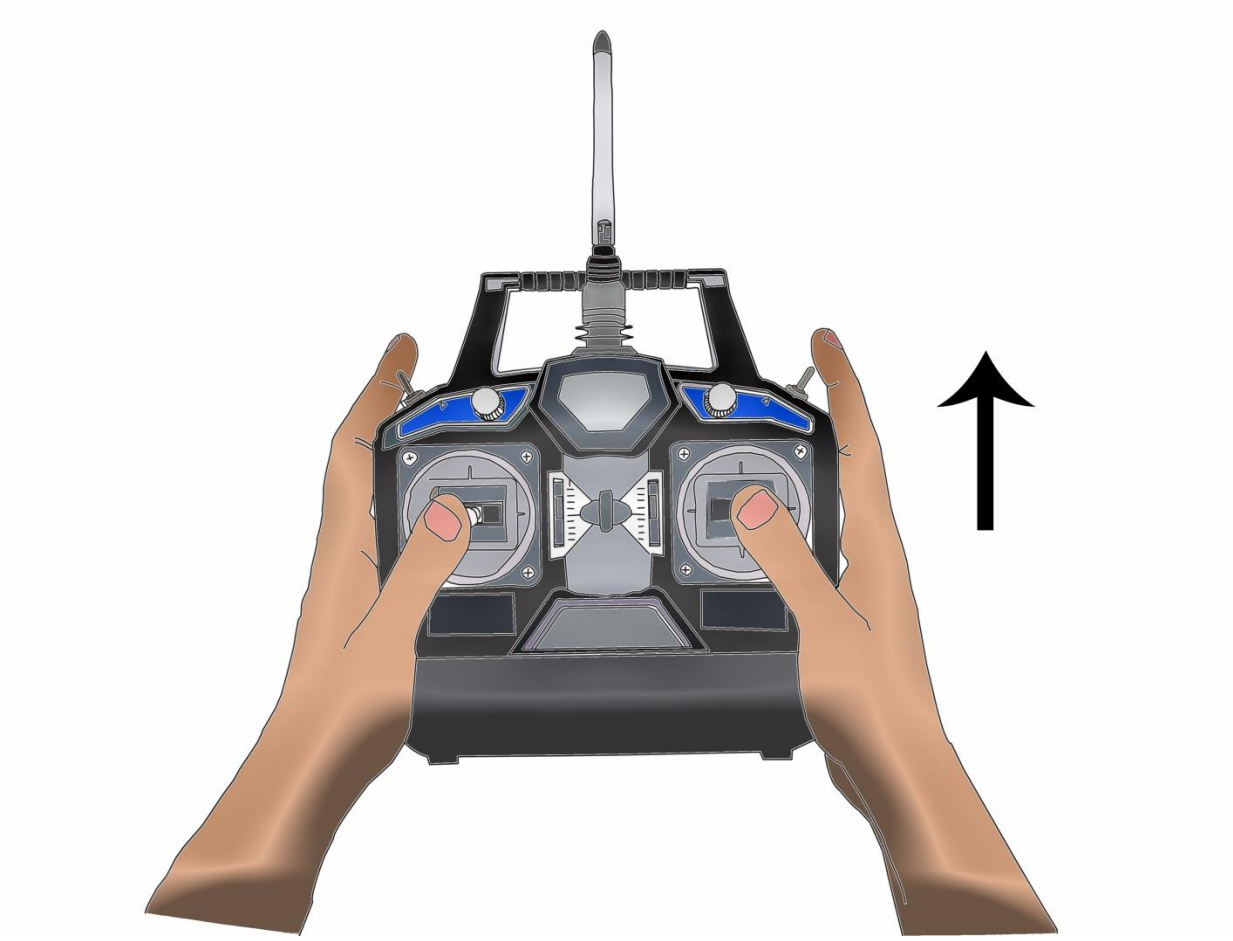


Figure 1: Pitch forward to move the craft forward

Don't just stand there, follow your craft! Use the throttle to maintain altitude, yaw to turn, pitch to go forward and roll to course-correct.

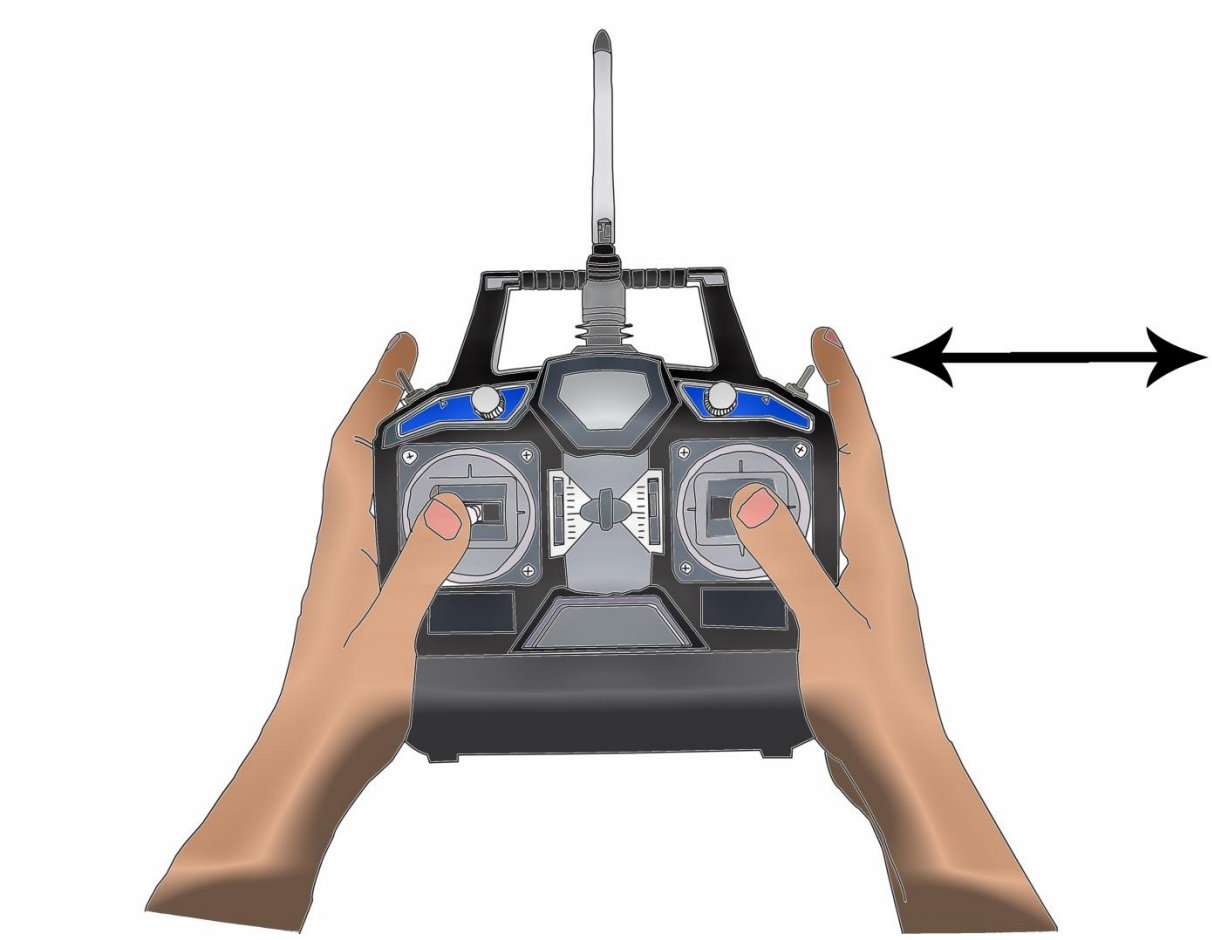


Figure 2: Roll to course correct

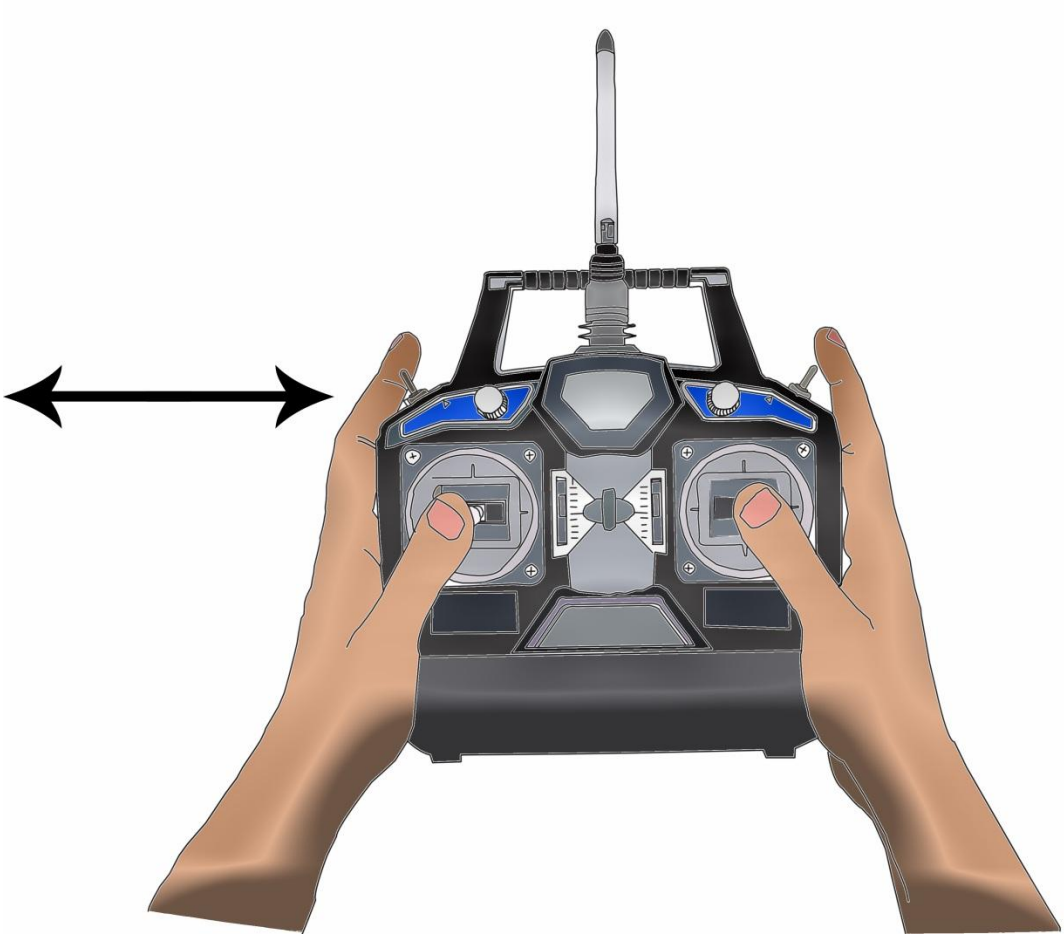


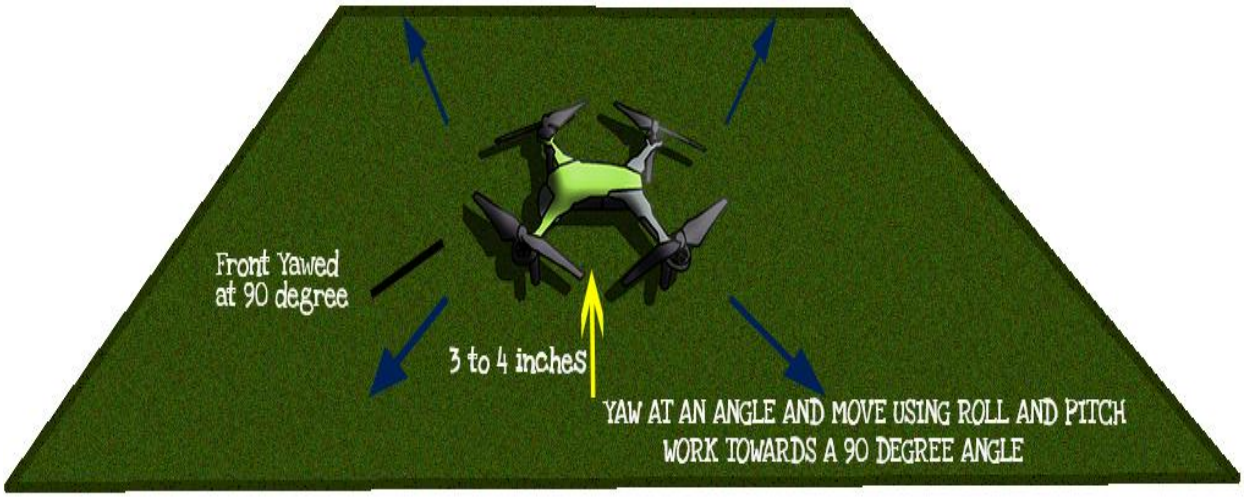
Figure 3: Yaw and turn the craft and follow the craft's tail

Follow your craft so that it is facing the same direction as you are at all times. Don't make your craft fly too fast unless you are in the mood for some running exercise.

Keep a slow, steady pace and get a feel for how all the controls work together. That's the whole point of this exercise! Spend a couple of battery charges mastering this!

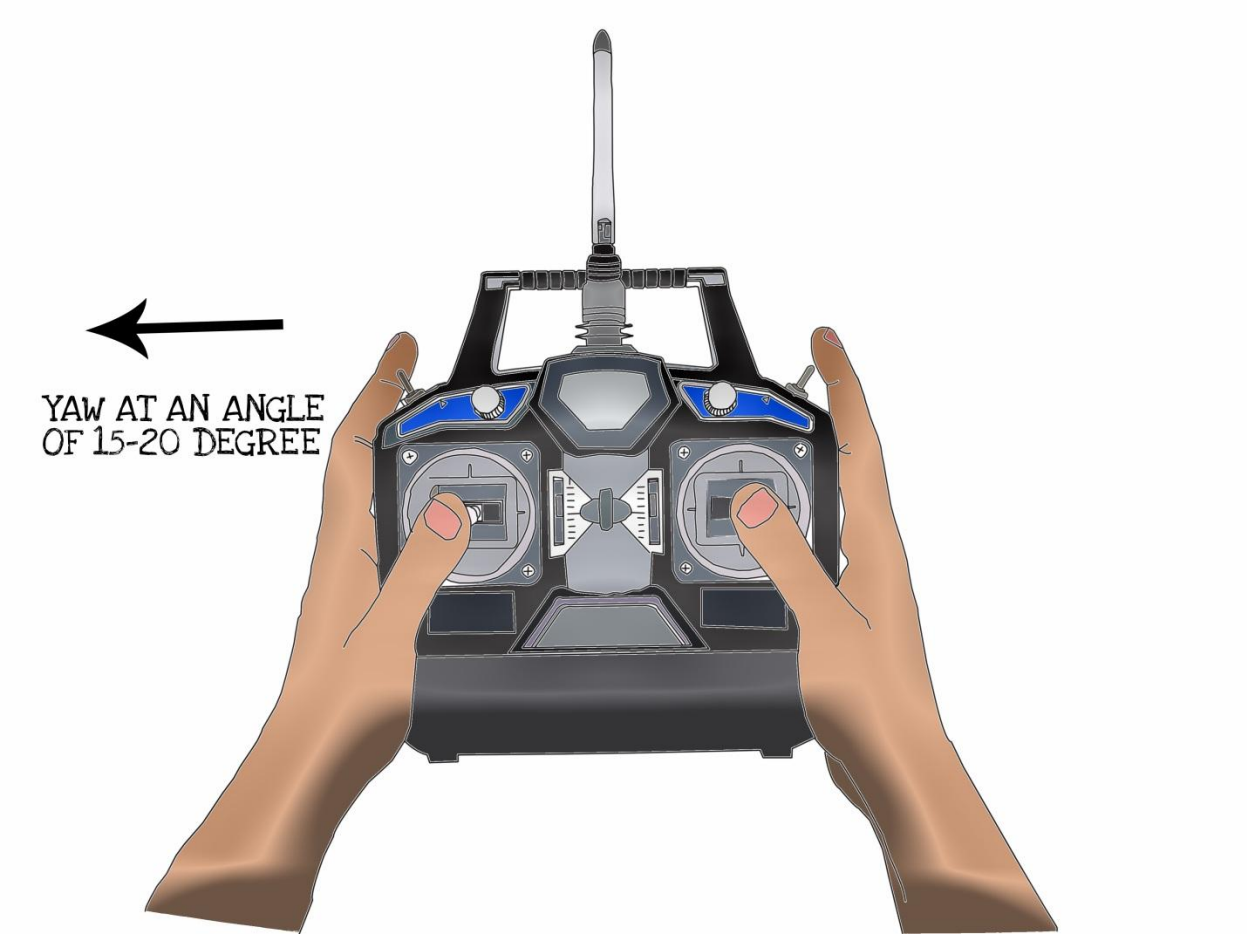
Lesson 3: Pitch and roll at an angle

Lesson 3.1: Low altitude

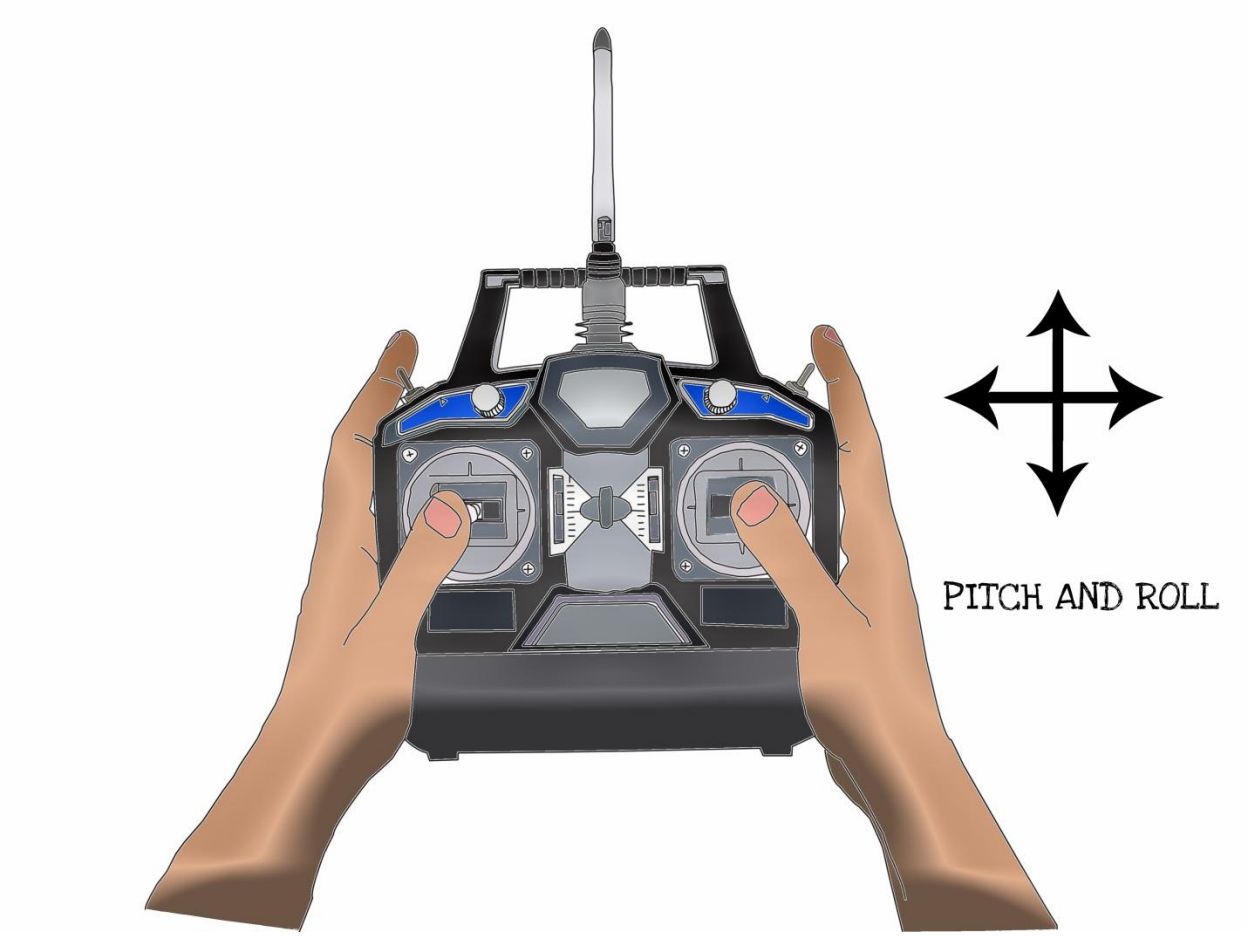


It is about time you learn how to yaw and fly the craft while it is not facing the exact same direction you are facing. This is where things might start to get difficult in learning how to fly a quadcopter!

Throttle up your craft to and make it hover around knee to chest height. Now yaw the craft at an angle of 15-20 degrees.



Fly around at this angle – Throttle, pitch and roll to move around. Again, visualize an imaginary boundary. Do not let your craft fly around frantically. Take it slow and easy. Make sure you have CLEAR visual at all times so you know you are doing it right!



Feels completely different now, doesn't it? The pitch and roll controls might now feel completely alien to you now that the tail of the craft isn't directly facing towards you!

(Don't forget to practice after you yaw in the other direction, at the same angle)

Once you get used to that angle, increase the angle to about 45 degrees. Practice at that angle. Keep increasing the angle (practice moving around with each increase) till it hits 90 degrees and practice flying around when it is at that angle. Again, don't

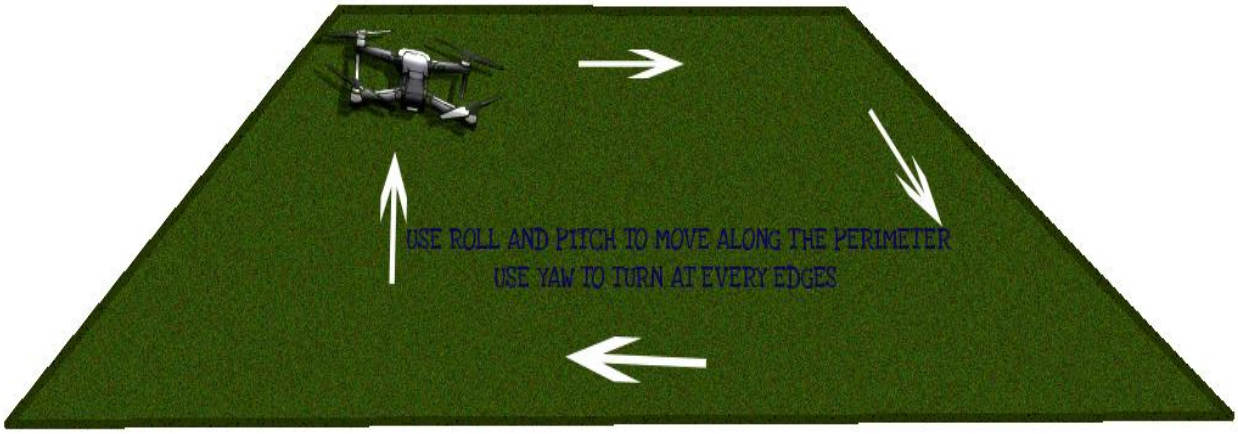
forget to work both directions of yaw. You don't want to be a lopsided pilot.

Lesson 3.2: High altitude

Drained a TON of batteries with the previous part of this mission? Now it is time to move up in altitude. Fly at around just above the height of your head and repeat the same process with the previous part. Make sure you absolutely master this mission.

Lesson 4: Learn to fly in a square perimeter

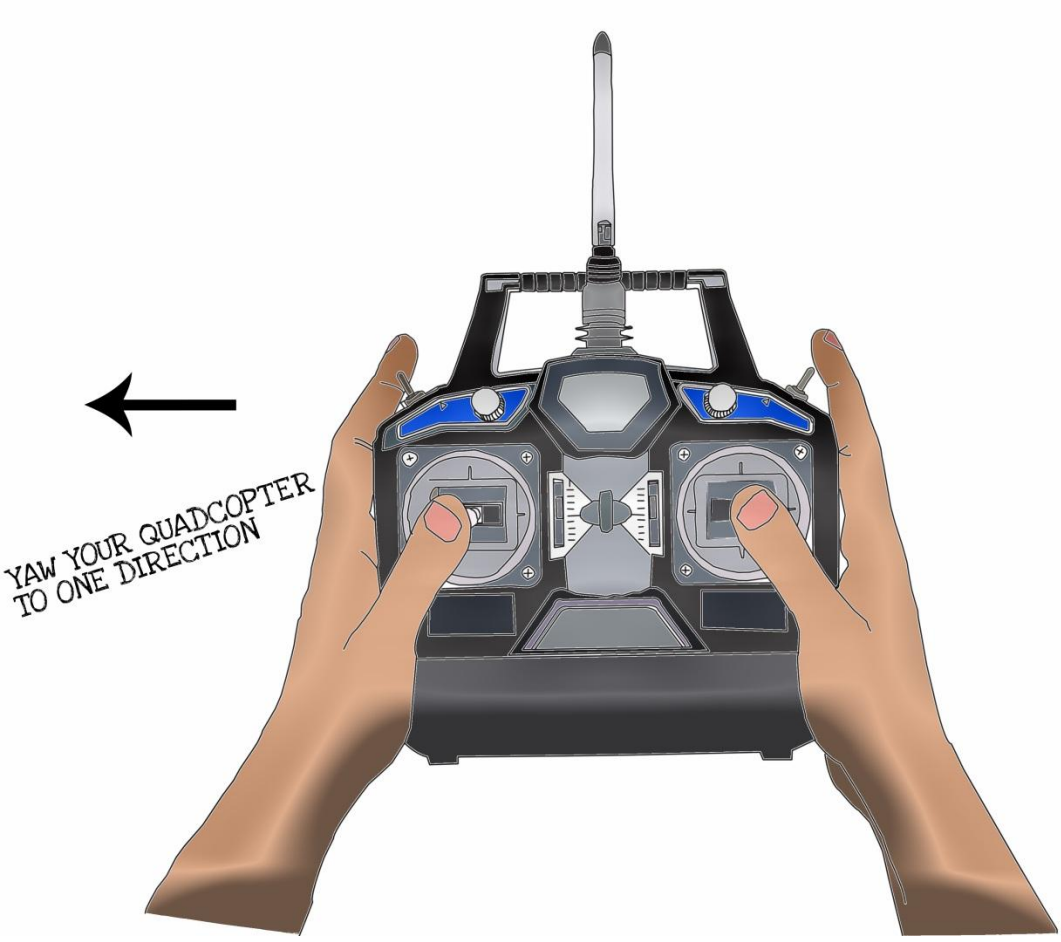
Lesson 4.1: Low altitude

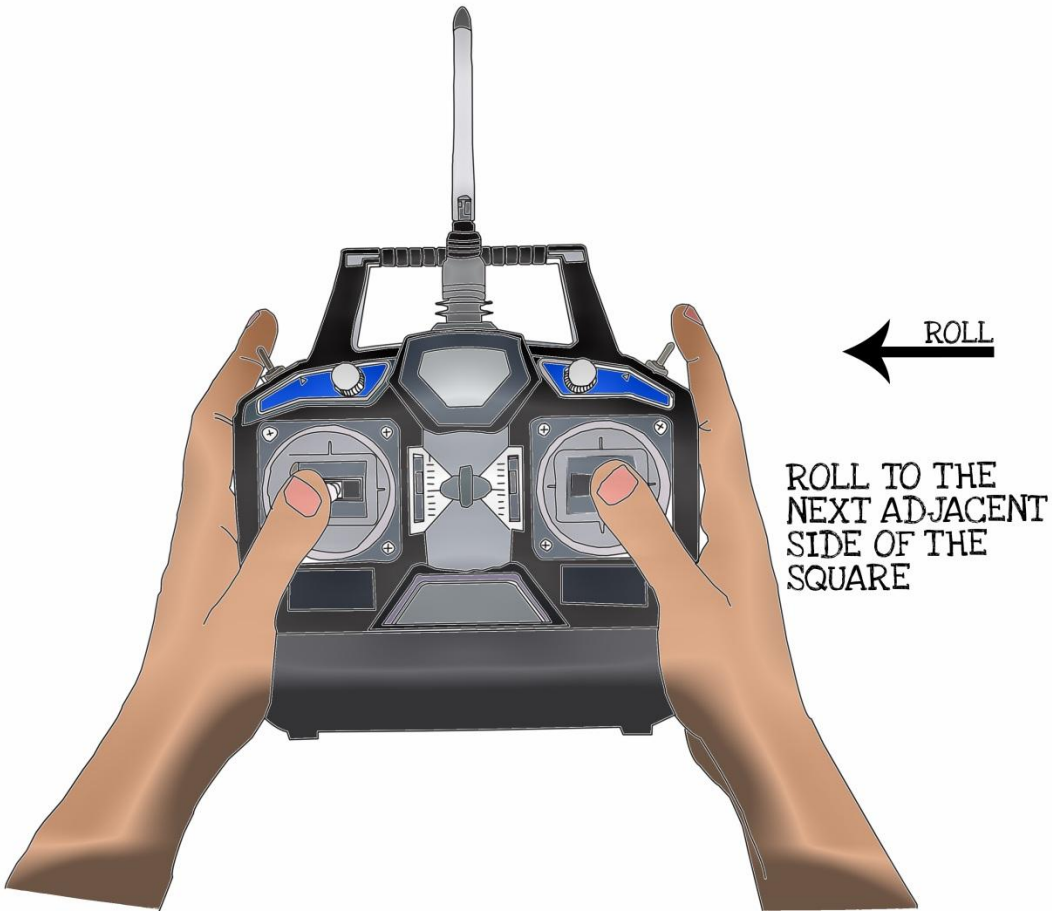


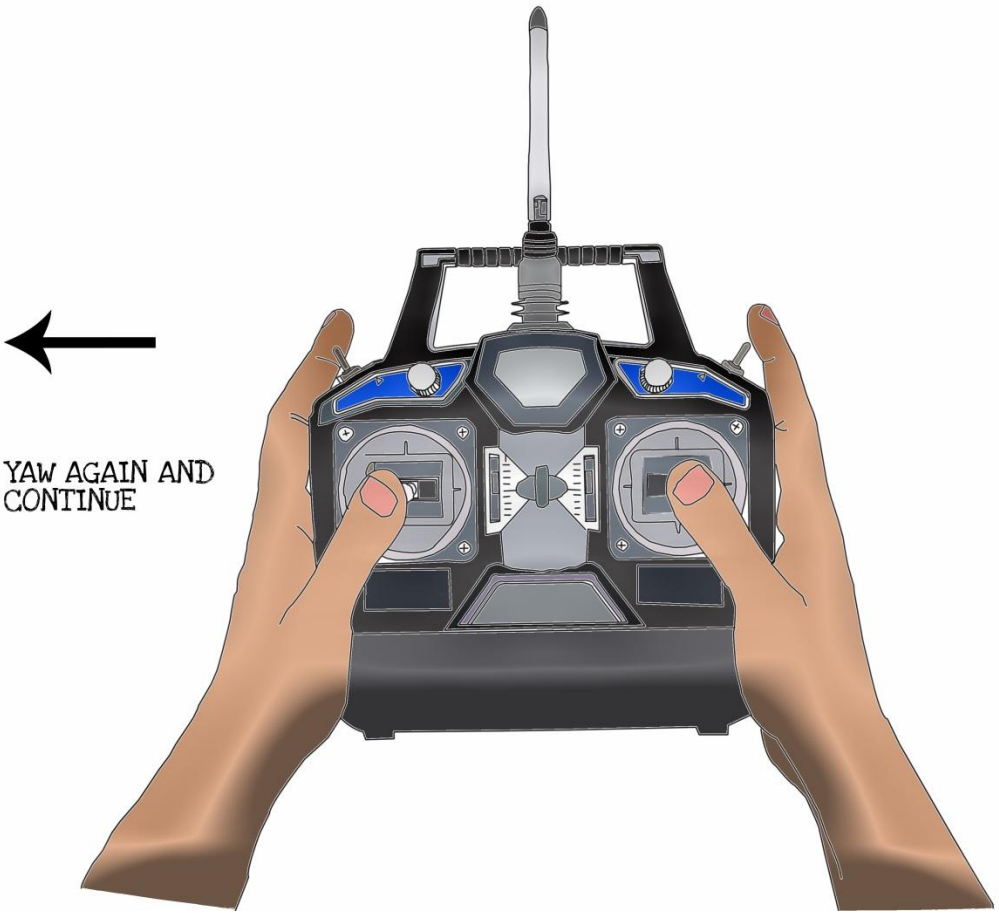
Mark a square area wherever you are going to fly. You can do this simply by placing four stones at four different corners. If you want, you can mark it by hoisting four poles at four corners to make that square flying area.

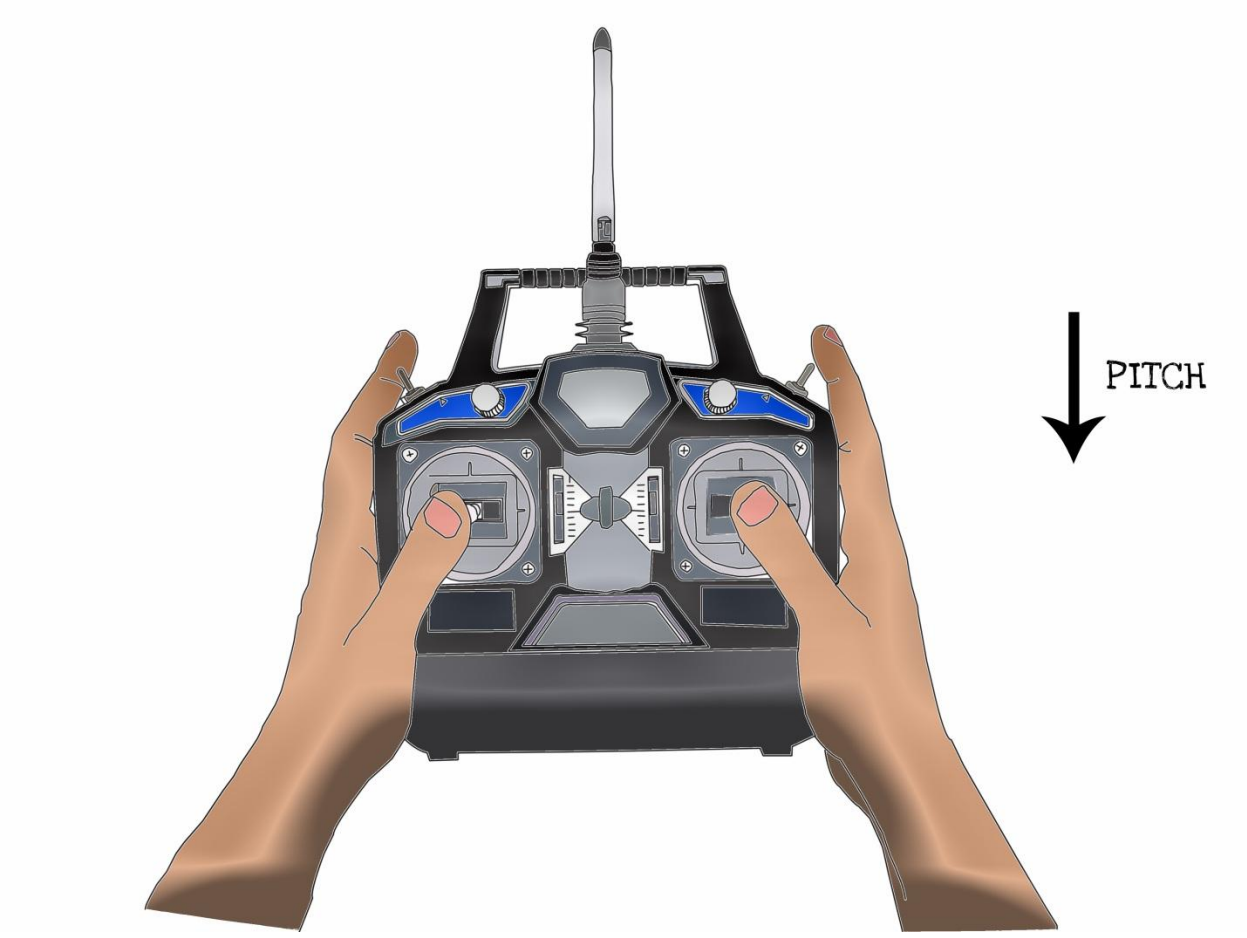
Now place your multirotor at one of the edge of this square or rectangle. Throttle up, hover at around knee to chest height. Now fly your quadcopter to the adjacent edge of the square and stop.

Now yaw your quadcopter to turn around and then fly to the adjacent edge of that edge.


YAW YOUR QUADCOPTER
TO ONE DIRECTION


ROLL
ROLL TO THE NEXT ADJACENT SIDE OF THE SQUARE


YAW AGAIN AND
CONTINUE



Your goal in this mission is to pitch, roll and yaw to fly along the perimeter of the square!

Remember – Do not rush this lesson on how to fly a drone. Make it deliberate and controlled. Stop at each edge. If you manage to complete a round, give yourself a candy with each completion. If you fall off the line of the perimeter by rushing things, slap yourself.

Also remember – Do both clockwise and anti-clockwise directions of the square perimeter. Again, you do not want to be a lopsided pilot!

When you mark the square, make sure to make it big enough to have enough perimeters to fly along!

Lesson 4.2: High altitude

Practice the same thing as before, at an altitude above your head. Master the square to master all the basic multirotor movements!

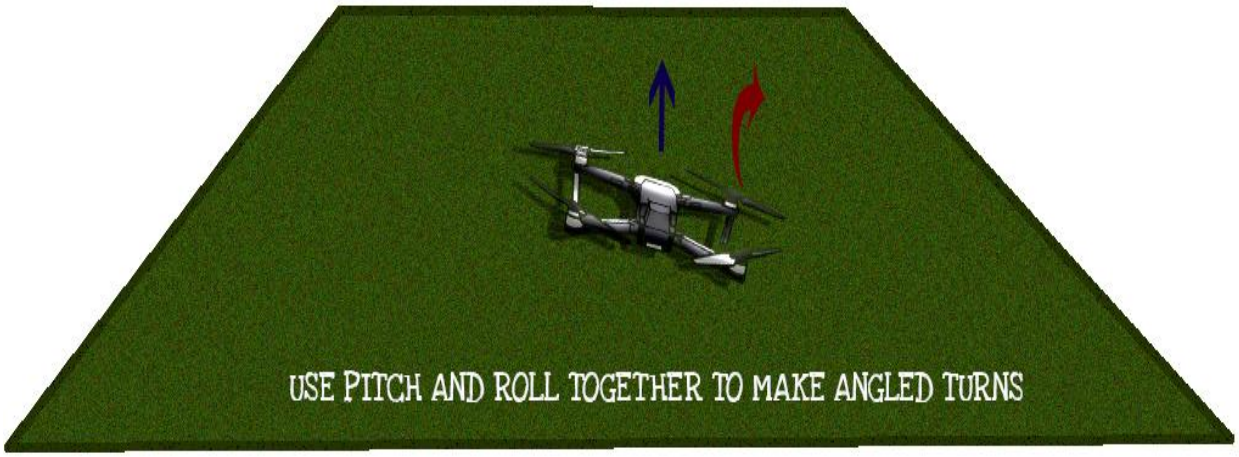
Lesson 5: Learn to fly in a circle (bank turns)

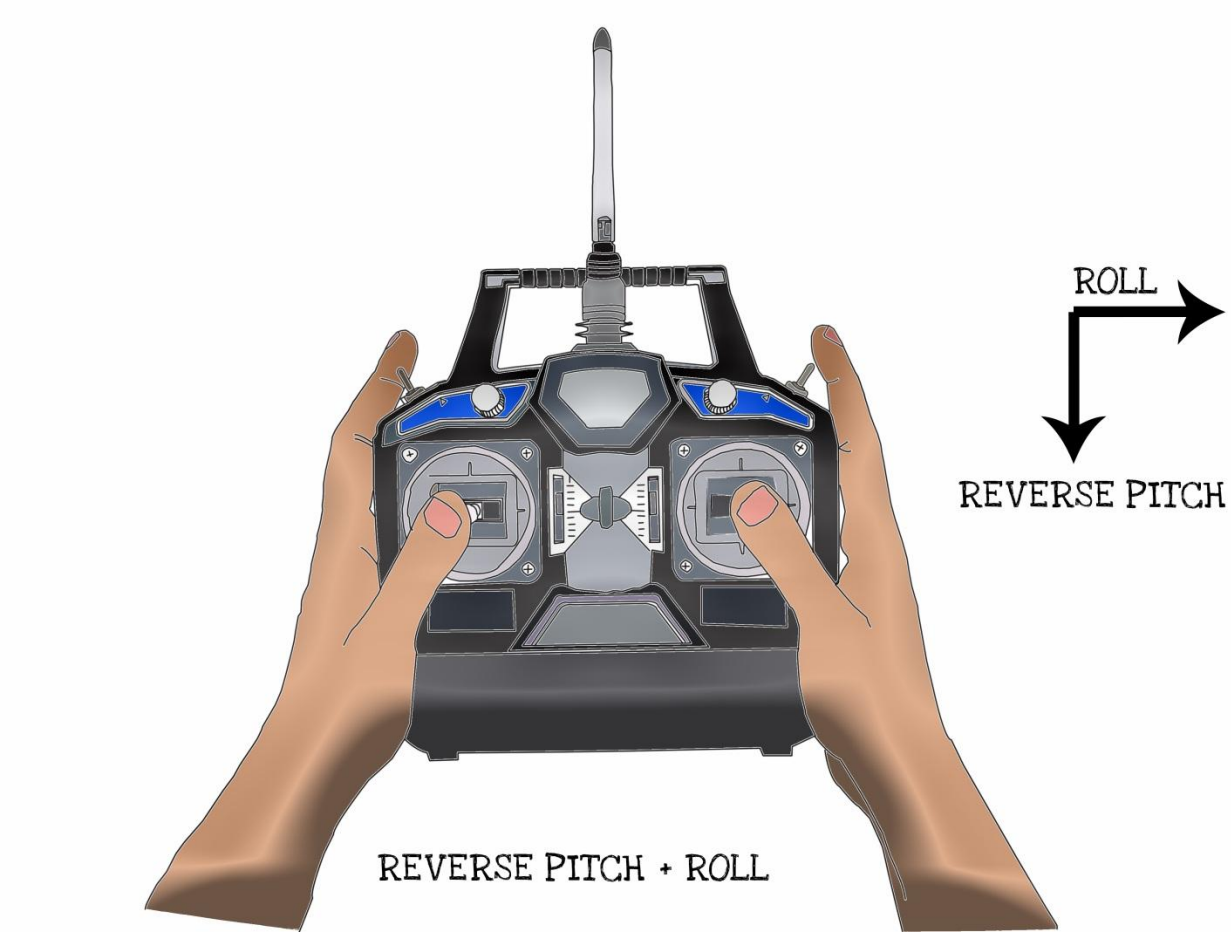
Lesson 5.1: Low altitude

At this point in your drone flying career, you should have a decent amount of 'feel' for flying the quadcopter. This is where you learn how to fly a quadcopter in a circle.

Like all of the other missions, it is recommended that you learn to fly a quadcopter like this at a low altitude before going up.

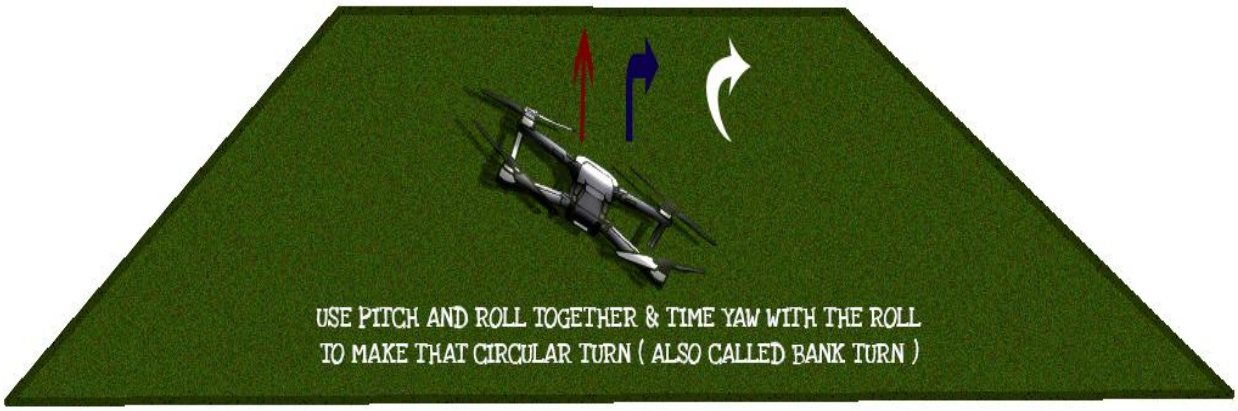
First, hover up at around **chest to head height or slightly above**. Now, while your multirotor is still facing away from you, with the use of both pitch and roll controls, go forward and make an angled turn (use roll with reverse pitch).

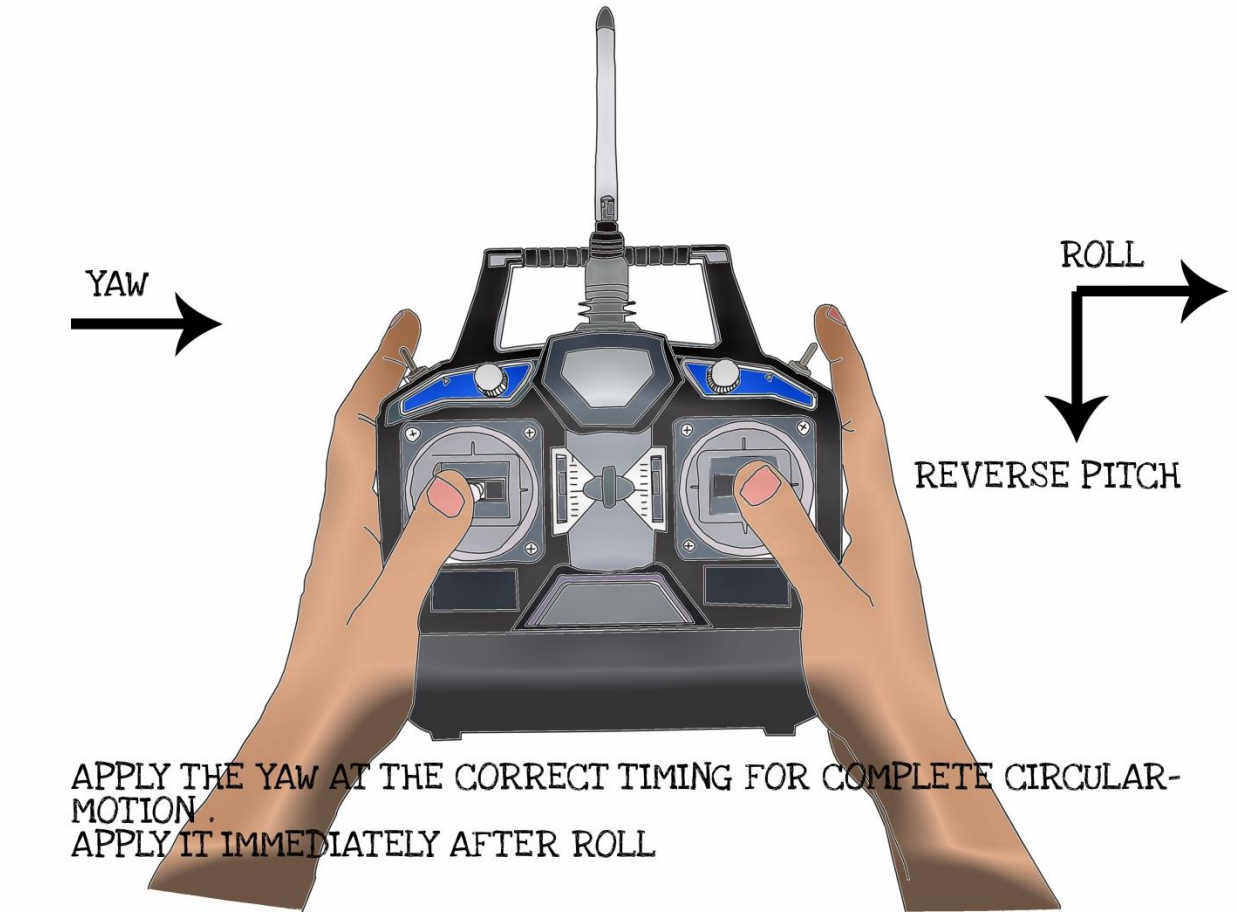




You may not be able to make a perfect circle at first but that's okay. Your goal at first should be to learn angled turns. You may experience that if you do not time the pitch appropriately, your multirotor will fall off due to the roll. Timing is key. After you have done a couple of these, it is time to move to the next step.

To make a complete circular motion, you have to apply the yaw motion into the process.





This will definitely take time to master, as it is about timing the yaw with the angled turn. Which is essentially timing it with the roll in the same direction. (First roll and then immediately yaw)

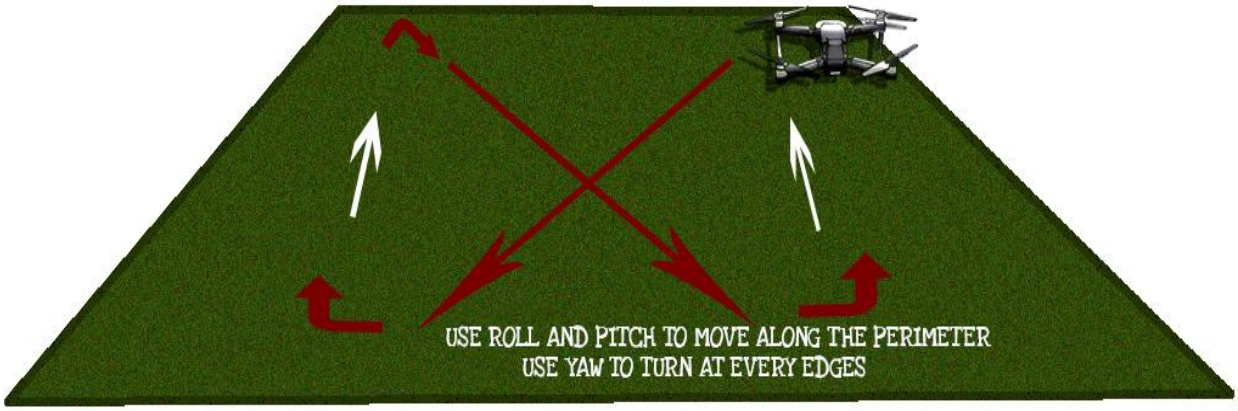
Lesson 5.2: High altitude

Time to move up in altitude. Practice the same process as before at a higher altitude. In this mission, higher altitude may feel easier because you have more room to recover from a fall before you crash. Nevertheless, it is important to get practice at different vantage points.

With both altitudes, remember to practice both clockwise and anticlockwise directions!

Lesson 6: Learn to fly figure 8s

Lesson 6.1: Broken 8s



This part of the mission is much like mission 4 of this how to fly a quadcopter series. Deja-vu!

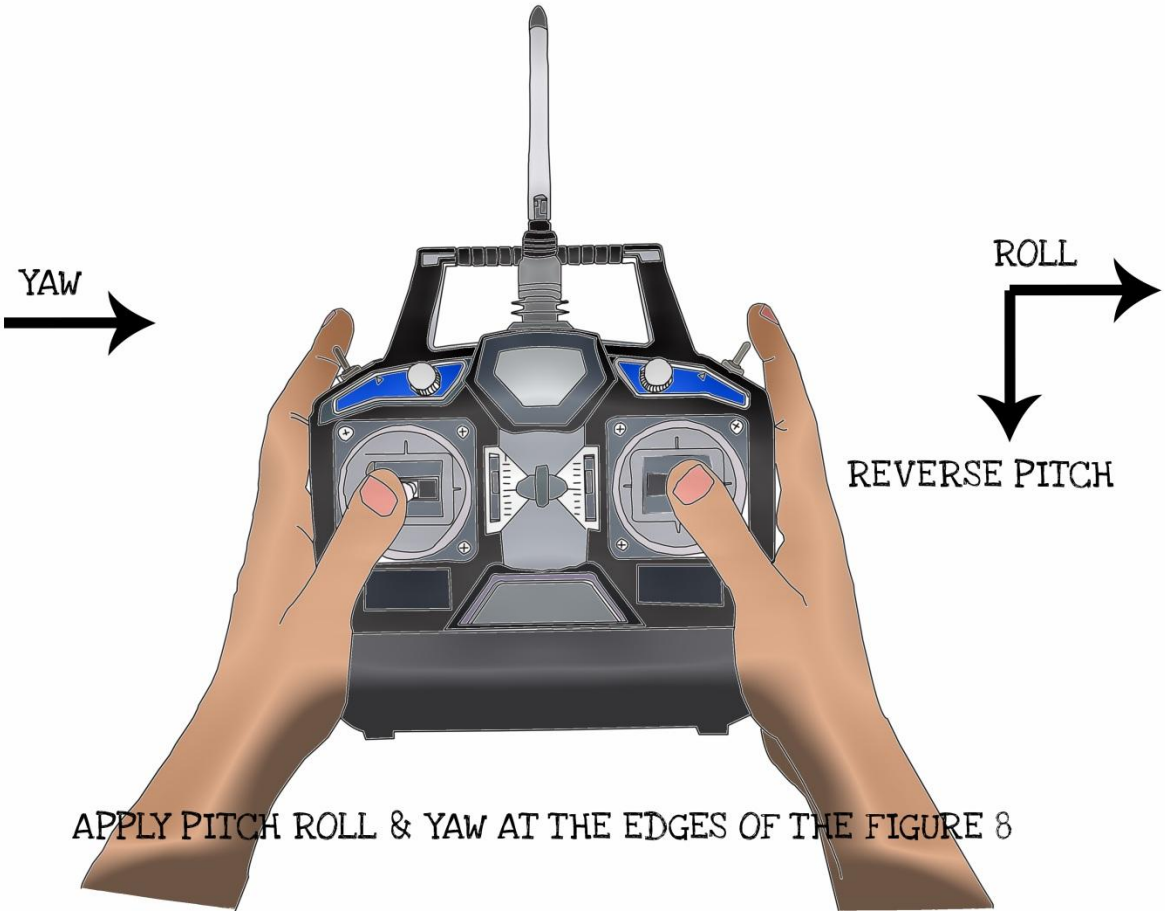
First, you have to mark the 'infinity figure' or 'figure-8'. Using the pitch, roll, yaw controls, move along the perimeter of the figure. Stop at each edge of the figure, turn using yaw and then proceed ahead with only pitch and roll.

Remember- slow, steady and controlled movement is what we are looking for here. Do not rush things, make sure you do not sway too much from the figure.

Make sure to practice both clockwise and anti-clockwise direction!

Lesson 6.2 Continuous 8s

This is where things get different from what you are used to with the earlier lessons of this how to fly a drone guide. Now you have to learn to apply what you have learned from both flying in the square perimeter and in a circle.



Same thing – move along the perimeter of the infinity figure. The difference is, you don't get to stop at the edges. After you reach the edge, you have to fly continuously and make the half-circle or 'smooth' turn at the edges using pitch, roll and yaw.

You don't have to fly at high speeds. Keep the altitude at about head height and fly slowly but continuously, without stopping.

Lesson 6.3: High speed, high altitude 8s

Alright, time to go up one notch. Same thing as in part 2. Fly along the perimeter of the infinity figure continuously, but this time take your craft up at a high altitude and try to go at high speeds.

Speed is key. Remember to pick an open spot with no people. You do not want to injure anyone in case of a crash accident.

With this mastered, you are getting really close to being a Jedi multirotor pilot. Well done, get yourself a beer!

Lesson 7: Nose-in piloting

Lesson 7.1: Nose-in hover

Lesson 1 all over again. Only this time, instead of the keeping the craft facing the same direction you are facing, keep it facing directly opposite to it. That is, the 'nose' of your multirotor will now be facing towards you while you learn how to fly a quadcopter!

Use the throttle, pitch and roll control to hover the multirotor in place, about 3 inches above the ground. This will feel completely different from what you experienced in Mission 1 as the controls are now completely reversed.

Lesson 7.2: Elevated nose-in hover

Alright, now it is time to do the same thing you did in part 1 of this lesson, only the altitude should be a bit higher than your head to get a practice for the difference in perspective and how the air behaves at higher altitudes.

Lesson 7.3: Move around with roll and pitch, nose-in

Move around with the roll and pitch of your craft, but this time, keep the craft facing opposite of the direction you are facing. That is, keep it nose-in.

Like lesson, Remember not to move around frantically and all over the place. Visualize or mark an imaginary square boundary and keep your movement within that boundary.

Lesson 7.4: Nose-in walk the dog

Follow your craft, but this time the craft should be 'nose-in', facing opposite of the direction you are facing. Use the throttle to maintain altitude, yaw to turn, pitch to go forward and roll to course-correct.

Don't make your craft fly too fast or you will have to run to chase it. Remember, getting used to the controls while going at a slow, steady pace is the whole point of this exercise.

Lesson 8: Switch between tail-in and nose-in

Lesson 8.1: The hover switch

In this lesson, you must combine what you have learned from lessons 1, 2 and 3 with 7 of this how to fly a quadcopter guide. First, practice hovering around when your craft is facing randomly in any direction. Rotate your multirotor with the yaw and stop at a random direction.

You should be able to switch up your reflexes as required and hover the multirotor at any angle – tail-in, nose-in or anything in between.

Start practicing at low altitudes, at about 3 inches above the ground, then move onto higher altitude hovering.

Lesson 8.2: The flying switch

Like lesson 6, fly figure 8s. But this time, your multirotor must be facing nose-in. Similar to how you practiced before, fly at a slow pace first. Stop at the edges of the figure and turn using yaw. Proceed with pitch and roll after.

After you have done that, practice flying continuously while making that 'smooth turn. Again, slow pace first. Go up a notch

and fly at high altitudes and high speeds after you have practiced the slow continuous flight, just like mission 6.

Switch up between clockwise and anti-clockwise directions. Also, switch up between tail-in and nose-in! Train your reflexes to be reactive to any scenario that might get thrown at you during your multirotor flying adventures! Do not leave any holes unfilled while mastering how to fly a quadcopter

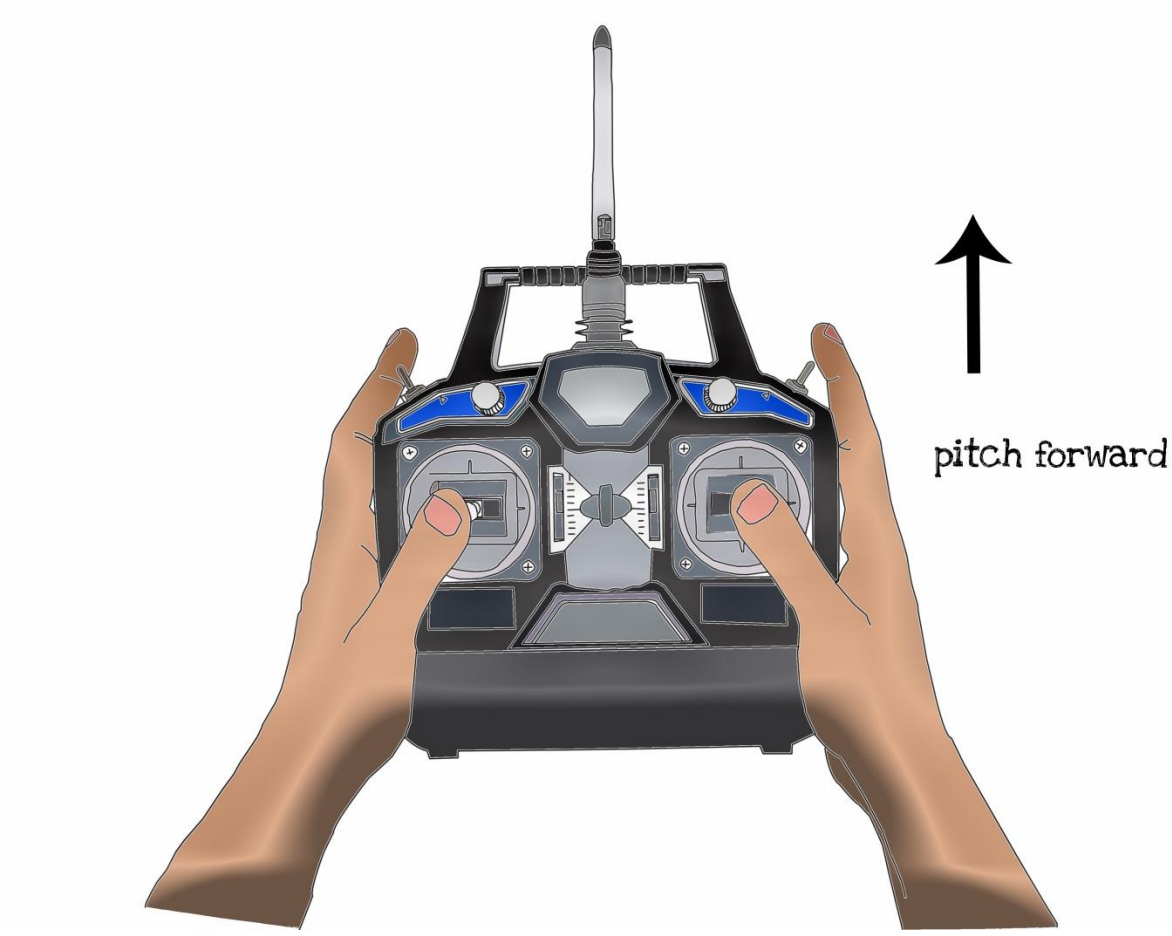
If you have mastered this step, CONGRAGULATIONS! You can now be classified as an enlightened Jedi multirotor master. You are now capable of flying and maneuvering around your quadcopter/multirotor like a true master.

Advanced maneuvers

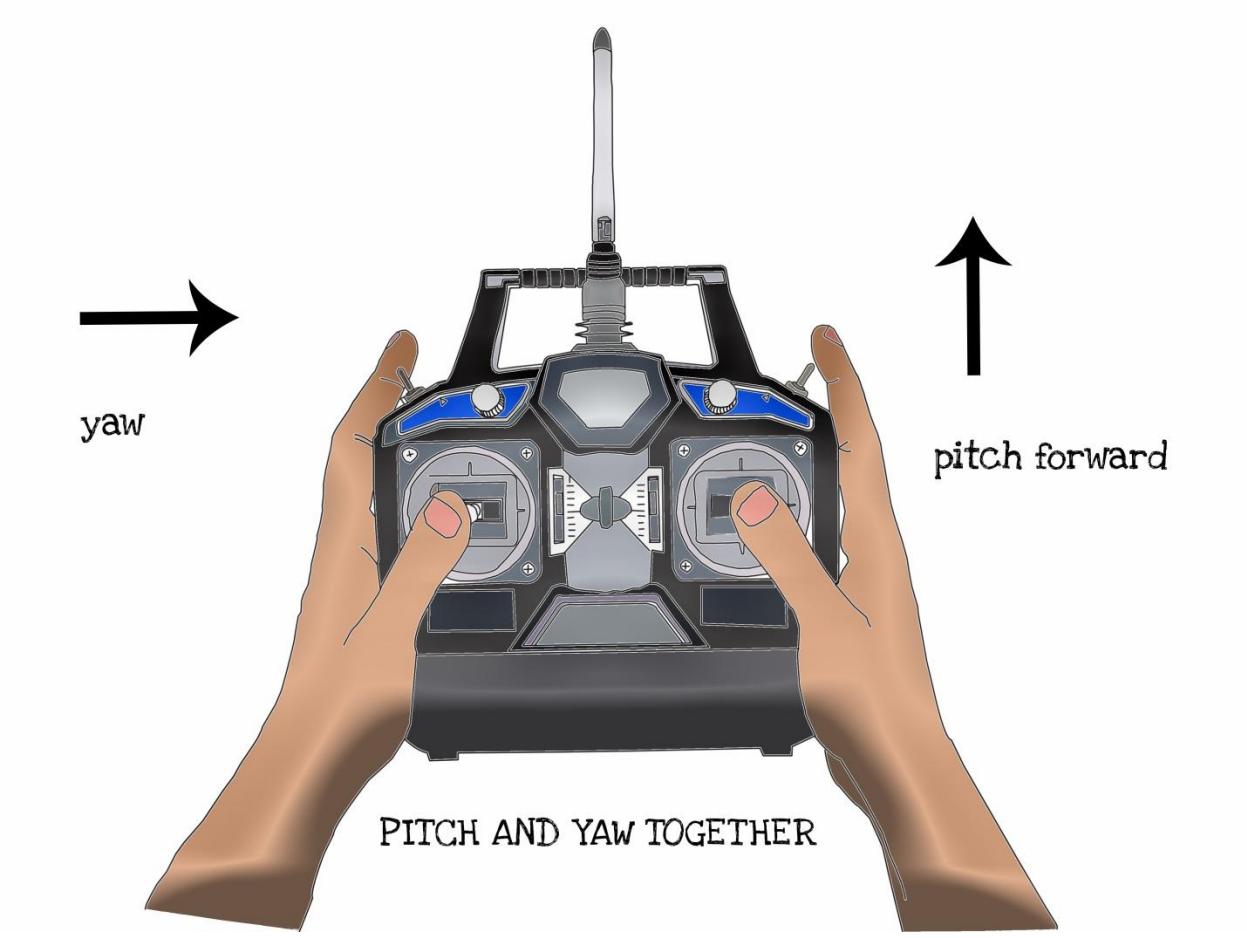
Now that you have mastered the eightfold missions, you can now have some fun with advanced quadcopter maneuvers. Proceed with caution and always do these advanced tricks in an open field with no people or pets around.

Flying a quadcopter in funnels

Funnels look amazing but before you perform this, make sure your multirotor is at a decent altitude. Once you have attained some altitude, pitch forward and gain some speed.



As the multirotor is moving forward and leaning in, hit yaw in either left or right direction to make your multirotor spin like a 'whirlwind' at 90 degree angles. Only attempt this trick when there is little to no wind.



To make it look even better, briefly roll in the opposite direction of your yaw while you are still pitching forward and then both roll yaw in the direction of you want to whirlwind. Timing it is the important thing here.

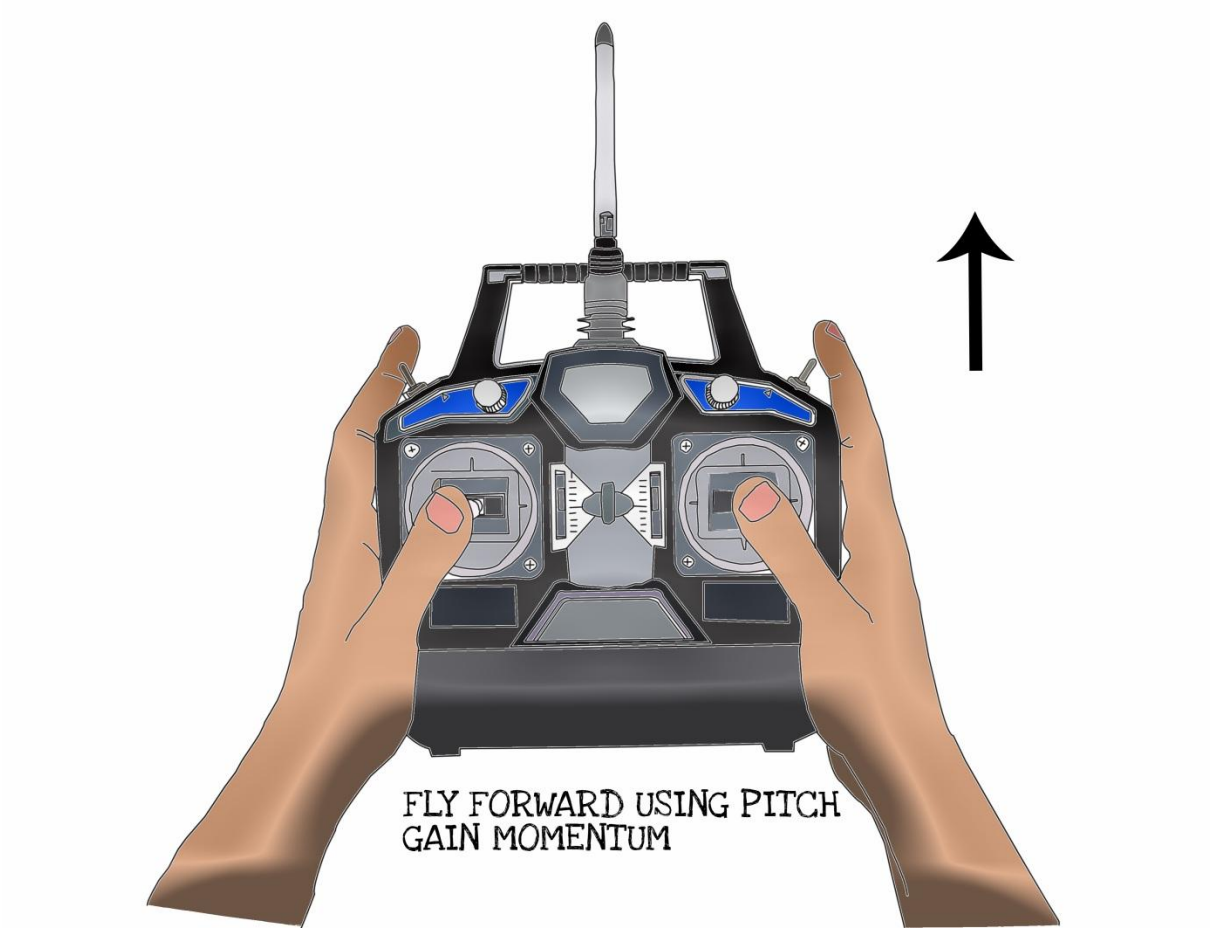
Multi flip-drop

To perform multi flip drop you need plenty of altitude. After you have climbed up, multiple flips are achieved by first making a regular flip and then cutting off the throttle right after the first flip.

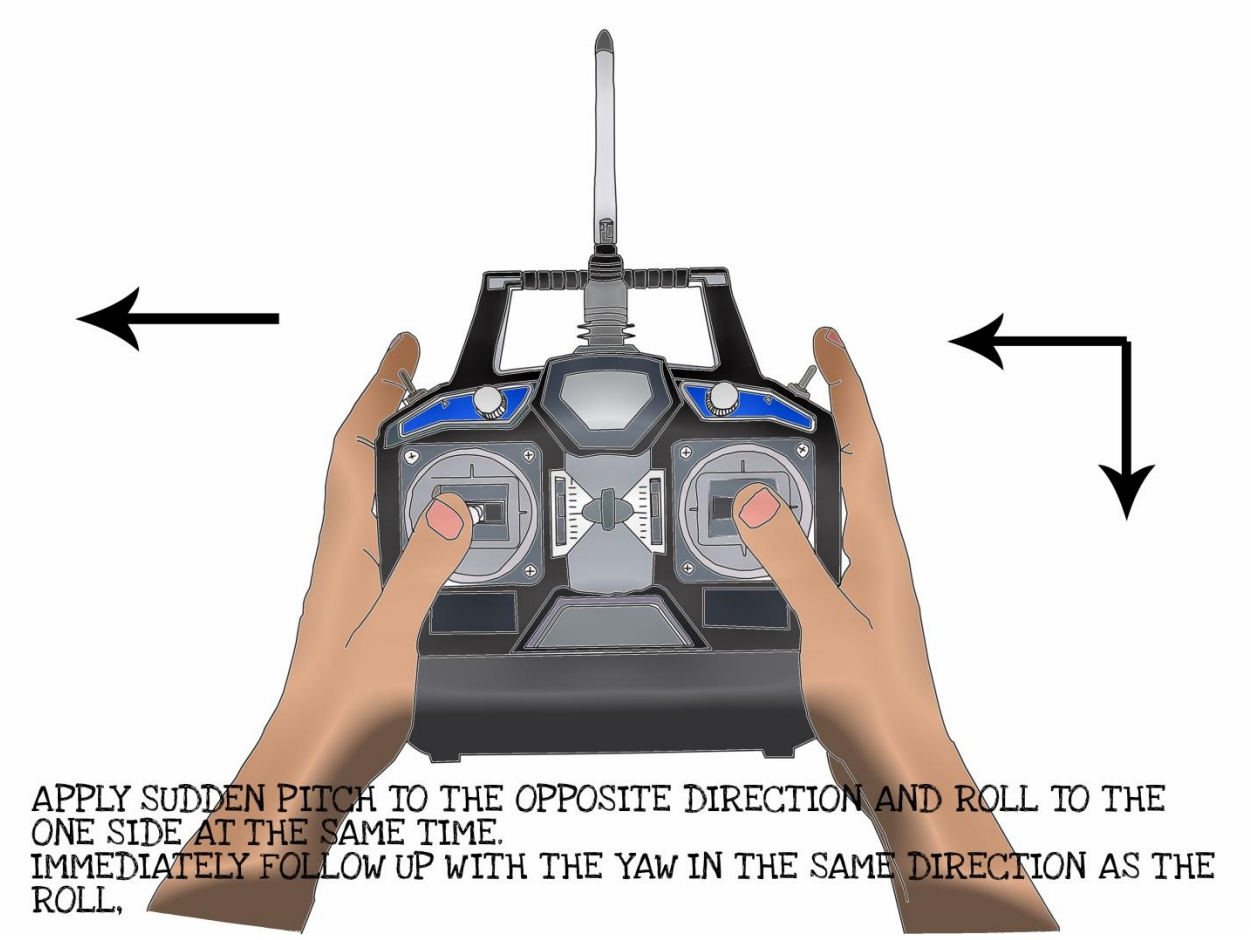
Using the momentum of that first flip, let it flip multiple times as it drops down in altitude. Ramp up that throttle again before it hits the ground to complete this awesome stunt!

Breaking Turns

These look plain awesome. This trick is achieved by a sudden change of direction to the opposite direction while your multirotor is in motion.



To achieve this, you need to suddenly pitch to the opposite direction while also rolling and yawing to any direction (left or right).



What this does is put a sudden break on your multirotor and using the momentum of the roll and yaw motion, switch to the other direction and be ready to fly in that direction.

Addressing drone flight modes

Auto-takeoff and landing

The headline says it all. Many semi-professional to professional drones come with this feature. You can even find hobby grade varieties (on the pricier side) that have this feature these days. Simply press a button, flip a switch or tap on your app screen and you are good to go!

Course-Lock mode

Switch on the course-lock mode and "forward" is the direction the drone is facing regardless of the orientation of the nose. This is usually done by using a compass built inside the drone. Bye-bye to nose-in piloting forever? Not quite, because you still want to be able to quickly change and maneuver in case technology fails you. If you are ever planning on piloting a $1500 drone and you forget to course lock or it fails, you need to have the ability to bring your drone back!

Headless mode

Headless mode is very similar to the course-lock mode but the key difference is that with headless mode, the forward direction of the drone is relative to the direction of the remote control. There is usually no inbuilt compass. This mode is usually found in hobby grade quadcopters.

Home-Lock mode

Home- lock mode is an amazing feature. With the pull of the right stick (usually), you bring the drone back to you and hover near you no matter what orientation the drone is facing and how far the drone is from you.

The main advantage with this feature is that unlike the return to home function, you actually have control over the YAW function of your drone while the drone is in flight and you can also push the right stick to move the drone away from you mid-flight. Semi-pro to professional drones have this mode. Hobby grade varieties usually don't.

Return to home

Very useful for emergencies, the return to home function is useful to quickly bring the drone back to you, with the press of a button. Most hobby grade drones and above have this function.

Selfie mode

This comes on 3DR drones. The camera is focused on the pilot while the drone flies away.

Waypoint mode

Set a pre-determined path and the drone will follow this path by itself. This feature comes in semi-professional to professional grade drones.

Point of interest/Orbit mode

Set a point or object of interest, the distance from it and the drone will revolve around clockwise or counter clockwise with the camera pointing at the target. If you are trying to achieve this while moving in a car or boat, you have to do this manually. Time to use that manual skill of yours!

FPV pilot training

After you have mastered the eightfold missions, you are now all set to learn how to fly FPV drone with camera and other fancy features. It is necessary to master regular line of sight flight before moving on to FPV especially because cameras and FPV equipment are subject to fail.

You need to be able to quickly switch back from FPV to LOS flight and bring your multirotor back to you and land safely in such scenarios.

FPV piloting is a completely different ballgame. It will require some additional practice before you can actually enjoy it without crashing and burning.

With FPV, we become handicapped in our ability to judge height, distance and velocity of our craft. It is hence necessary to train our neurons and eyes to this new perspective. If you live in a particularly windy area, it will take some time getting used to adjusting for wind directions when your situational awareness is handicapped with wearing FPV goggles.

Tips before you get started

- Like regular flying, start practicing in an open field with no people, objects and/or pets around
- Like regular flying, take it one step at a time. Master each lesson before going into the next one.
- Consider starting off with learning on a simulator like Lift-Off.
- Start with a cheap yet sturdy drone and components. Again, it is not a matter of IF you will crash, but WHEN you will crash, especially if you are not particularly skilled.
- Start with practicing how to fly FPV with the camera tilted to about 10 degrees.
- Watch and learn from others. The best way is to watch videos of FPV flight.

Lesson 1: Hovering

Back to basics: Although this shouldn't take long since you have your fundamentals down already, the first thing to learn is to get a feel of the new perspective. First of all, learn how to hover with the FPV gear on.

Ideally you should turn off the flight stabilization features so you actually apply your Jedi skills on the FPV perspective, during hovering. When you proceed to coming lessons, you can turn on flight stabilization features for additional control during FPV flight.

Lesson 2: Flying in a line

Go to an open field with little to no trees or other objects. Mark two end points to make up a line. Your goal with this lesson is to fly along that line with FPV gear on.

Pitch forward, roll to keep yourself from drifting with the wind and yaw around when you reach the end of the line to turn around and head back.

Repeat this process till you are really comfortable with flying in a line. If it is windy, you will need to learn how to cope with the wind to keep from falling off course. Make sure you fly up in a decent altitude.

Lesson 3: Flying in a square

Same thing as before, go to an open field with little to no objects. A football field is a good example. Mark a square if you have to or just fly along the edge of the field. With this lesson, your goal is to fly along a square or the edge of the field. Pitch, roll (to keep yourself from drifting) and yaw and go around the field.

Repeat this process till you are comfortable. Again, learn how to really cope with wind. Try not to diverge too much off course.

Take it slow and easy, there is no need to go all drone-racy when you are just learning. Crashing is never fun. Minimize the possibility for it.

Lesson 4: Flying figure eights

Once you are used to flying FPV in a square, it is time to take it up one more notch and do figure eights with your multirotor. Like in the eightfold path to mastery, first go slow and stop at the edges, yaw and then proceed to the adjacent edge of the figure.

After you have mastered that, it is time to learn to make smooth corners and angled turns. Watch out for the wind as it can really blow you off course, especially with figure eights. Go slow but continuously. There is no need to rush things in the beginning.

After you have mastered the figure eights while flying slowly, it is time to go fast and high. With that nailed down, you should now be able to fly FPV in almost any scenario.

Free flight and drone racing

With practice, you will eventually get to a point where you will be able to do advanced maneuvers while on FPV. These include being able to roll and flip, seeping and maneuvering through small gaps etc.

Drone racing experts are especially good at FPV free flight. It is worth mentioning that it is necessary to have customized builds for your multirotors for drone racing. It is near impossible to drone race with regular mainstream multirotors that is typically used for filming.

Flying Indoors

Should you fly indoors? Why fly indoors?

You may wonder if you should attempt flying inside at all. After all, it should be much safer outside, in an open space outdoors. While this is true, it might actually be a better idea to practice flying a drone inside, provided you setup your environment carefully and pick the right craft.

Learning how to (manually) fly a drone can be challenging but worth it. It might actually be best to start learning it at the comfort of your home, without having to head out where you are subject to potential rules and regulations.

The main reasons you may think of as to why you should consider flying a drone indoor are:

- Learning to fly.
- Not having to be concerned about breaking the law or flying onto someone's cat.

But that's not all of it. Flying drones indoors can be incredibly handy in bad weather when heading out is not an option. Another reason why you might want to consider mastering indoor flight is if you are a real estate photographer. With drones added to your repertoire, you will be able to capture stunning, photos and videos of homes like never before.

Fun indoor flying ideas

Who says all the fun is outside? With proper setup, you can have some fun competitive experience with your friends indoors!

For example, clear all the furniture and potential breakable objects in a decently sized room. Set an obstacle course inside with simple rings attached to the ceiling, hanging on different lengths/heights. This is a fun way to improve your flying skills indoors, especially when the weather is dire outside.

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What drone to pick?

The best drones for indoor flight are really tiny nano drones the size of a coin and micro drones that can fit on your palm. Of course, for real estate photography and similar tasks, you'll need something that can carry a decent camera and these drones tend to be bigger.

However, if you are a hobbyist looking to have some fun or if you are beginner, go for the Nano or micro type drone. Generally speaking, the smaller your craft, the better it is for flying a drone indoors.

A Nano quad maybe the best option for indoor flight and obstacle course. At the same time, smaller it is, the worse it will handle winds if you take it outside. So do consider this before going for Nano quadcopters!

The best part is, if you are not keen on flying outside or taking high end photo/video, you can get away with something really cheap.

Other purchases you might want to make are:

- Spare propellers, propeller guards
- Extra LiPo batteries (for more flight times)

Considerations for flying a door indoors

Start slow and learn gradually

Think it is wise to fly around the quadcopter like crazy after unboxing it for the first time? If you are a beginner, think again. You must approach flying a multirotor systematically. Start slow and learn how to fly it gradually. Learn how to hover first, proceed to basic flying patterns before moving onto more advanced moves!

Obstacle courses and challenges can come later. If you are a beginner, get used to the controls and controlling your quad! Master it. Not only will this help with safety, you'll be equipped with enough skills to move onto flying fancier quads outdoors.

Although these come with autopilot features, you never know when the training wheels come off. If you are skilled, you can always maneuver your way out of trouble! Drone racing and FPV flight will also be within your reach if you have a solid base.

Clear the room

Before you go about flying a drone indoors, clear the room off obstacles that you don't want damaged. Do not underestimate

propeller cuts. You do not want that awesome piece of art work messed up by your quadcopter!

'Obstacle' courses can be constructed using rings and plastic/metal toys that aren't so easily damaged but do not put your expensive stuff at risk! And especially if you are starting out, you ideally don't want obstacles at all, so find a room that is spacious and open.

Be careful no one walks in unaware while you are flying a drone indoors

Make sure there are no pets or kids around when you fly your quadcopter and be careful not to let other people walk into the room you are flying unaware. To reiterate what was said earlier, do not underestimate the damage even small propellers spinning at high speeds can cause.

To share a personal story, I had a propeller strike accident while building a small 250 sized quadcopter. Fortunately, the cut was on the shin area and all it took was to have the skin healed but even so, the cut was deep and the mark still remains. However, had it been somewhere like the eye, things could have been far, far worse.

Please note that this is not to scare you but to prompt you to take enough safety precautions. Accidents happen with almost any endeavor but it doesn't mean we should stop doing everything, like flying a drone indoors!

Install propeller guards

Propeller guards are excellent not only to reduce damage to the quadcopter, but also to reduce the chances of damage your quadcopter can cause to objects and/or people. Most Nano and micro quadcopters come with prop guards as they are designed for indoor flight but if yours doesn't, make sure you can get a spare one for the model and install it IMMEDIATELY!

The prop guards might increase the weight on your quad and thus potentially reduce flight times but that is not a good reason not to install one for indoor flight. You can always get additional batteries, but you cannot replace the safety boost a prop guard offers. Especially if you are a beginner and flying indoors, install propeller guards. No exceptions.

Avoid flying near walls and ceilings (unless that's part of fun)

Your quadcopter/helicopter will be unstable near walls, ceiling and floor due to the nature of the difference in air flow. It'll also be the case with bigger obstacles. Unless you are well past the beginner stage and it is part of a fun challenge you are undertaking, avoid treading to these areas with your craft.

What if you crash?

Though the points highlighted here may not help you reverse time to pre-crash, hopefully it will give you some direction.

Keep your cool

Try not to panic too much. You are not alone. Crashing is part of the game, especially if you are new to flying. As with any adversity in life, it is important to clear your head before making further decisions.

Crashing happens to the best of us, even for those who have been in the hobby for years. And guess what? Most of us got good after crashing and ruining our craft multiple times.

You can try to master flying with simulator apps and think you may never crash, but you will definitely need to have real world flying experience to get 'good' at it and this is very often accompanied by crashes and losses.

Take a few deep breaths, meditate or whatever it takes before doing anything drastic like throwing the damaged craft away!

Leverage it as a learning experience

Use the crash as an opportunity to learn more! After you have calmed your mind, look back and think about what went wrong with your flying. This is obviously an important step so that you do not repeat the same mistake the next time around. Learning iteratively is KEY to getting better.
Also, as you will see from the next few points, think of the crash as an opportunity to look inside the hood and figure out what is wrong and what is in there. As a bonus, you will have a much deeper understanding of the parts that make up these awesome flying machines.

Recover the damaged drone and pieces ASAP

Remember to go get that crashed drone ASAP, before it gets damaged further by the environment or bitten to pieces by your neighbor's pet dog.

Most of the pieces that make up the drone are probably still functional and not worth letting go. Especially if your drone is an expensive one like the DJI Phantom, it is important that you recover the pieces that are inside, even if the drone has crashed into a water body and seems irreparable.

Many experienced pilots will tell you that there were times they were dead wrong when they thought their craft was damaged beyond repair.

Also make sure to scan the area of crash thoroughly for any pieces that may have drifted away from the main craft.

Check if you can get the damaged parts replaced or repaired

After you have recovered your damaged craft, try making a thorough assessment of what has happened to your craft and check if it is possible to repair it – either yourself or by the manufacturer.

If you have a ready to fly model from one of the popular brands like DJI, you can contact them for repair services. Note that this can cost a lot, especially if your craft is an expensive one. However, it may still be worth it, considering you may have to pay the full amount for a brand new one.

If you are curious and have an affinity for tinkering with the insides of your drone, get your hands on some knife and soldering iron, and get ready to go. This isn't advised however, if your craft is an expensive RTF model and you are brand new to this.

It is important to have some understanding of the parts that make up your craft and what goes where, including figuring out the appropriate type of motors, ESC, batteries and other parts that maybe required to resurrect your craft.

Keep the working spares regardless

If for some reason you come to the harsh truth that your craft is beyond repair, instead of disposing the whole thing, check what parts are still working and keep them.

If you intend to continue on in this hobby, it is likely that you will crash again and it's a wise idea to have spare parts just in case. As you get more experienced and deep into hobby, it is not uncommon to have a ton of different spares and parts lying around for different purposes, including unfortunate moments of crashes.

Important Tip: Turn off that throttle

This point may not be for AFTER you crash your drone, but I think it is an important one to address – As soon as you know that your craft is headed to a crash, make that split second decision and turn off that throttle!

Why? Well for one, it can potentially minimize the damage caused to the propellers and motors of your craft. You don't want to be spinning that propeller into the ground – this is arguably the number one reason most people damage their craft beyond repair.

Secondly, it will minimize the chances that you hurt anyone, anything or pets during the crash. Sure you probably will have a bad day after a crash, but do you want someone else to have that too? In some cases, crashing a craft into someone can cause fatal injury to them and you definitely do not want that!

In Closing

Practice flying a multirotor till mastery. Though it is never really boring, the real fun begins when you are really, really good at how to go about flying your drone. Do not lose heart if some of the missions prove to be really difficult to master. Take your time but we recommend you do not skip through any of the lessons laid out in this book.

Once you have mastered the flying a multirotor, the sky is the limit. The doors to drone applications like photography, videography, FPV racing, land surveying etc. will be open to you. The important point here is that you will be able to handle them confidently, masterfully and artfully.